

Aquilegia

Magazine of the Colorado Native Plant Society

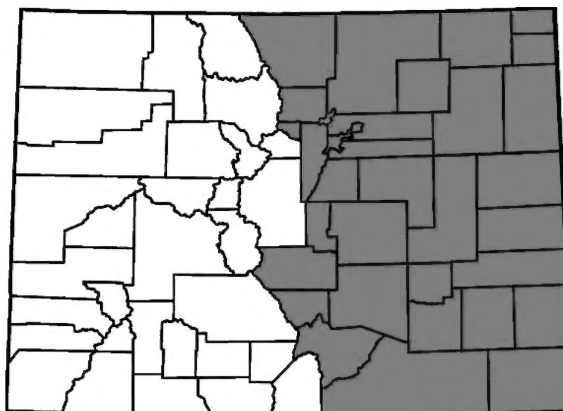
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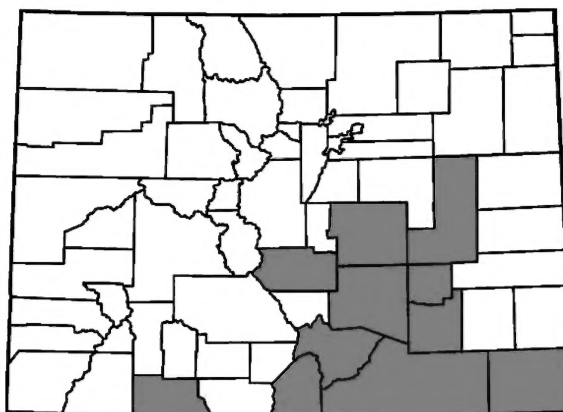
New Executive Director

The CoNPS Board of Directors is extremely pleased to announce that Maggie Gaddis, the current president of the Southeast Chapter, has been hired as the Executive Director of the Colorado Native Plant Society. Dr. Gaddis currently teaches biology, resource management, and conservation and sustainability courses at the University of Colorado–Colorado Springs. She is also a member of the Bard College Citizen Science faculty. Dr. Gaddis engages citizen scientists and students to develop monitoring programs that measure ecological-restoration projects in natural land settings where anthropogenic environmental degradation exists. She is also interested in the relationship between training design and the reliability of data collected by citizen scientists. Maggie will start as ED on September 1, when she and the CoNPS Operating Committee will begin to make plans for our new, exciting future.

PHOTO CREDITS



Front cover: prairie spiderwort (*Tradescantia occidentalis*). A plant common in the plains and foothills.



Back cover: cholla (*Cylindropuntia imbricata*) at Picketwire Canyon. Another plant found in the southeastern Colorado prairie.

Both photos © Sue Keefer. Maps adapted from J. Ackerfield, 2015, *Flora of Colorado*. Orange color denotes ranges.



This issue of *Aquilegia* contains information on the 45th CoNPS Annual Conference, which is titled “The Short Grass Prairie and a Long Look Back.” This quarter’s issue contains several articles on the shortgrass prairie and on the plants found there. Approximately forty percent of the state is prairie, yet this ecosystem has been understudied compared to the mountains. Furthermore, the prairie is proficient at capturing carbon, and therefore is important in mitigating climate change. We hope to see you in Trinidad in September as we learn more about this vital part of Colorado! Photo: Shortgrass prairie at Rocky Mountain Arsenal National Wildlife Refuge © Kelly Ambler.

Aquilegia: Magazine of the Colorado Native Plant Society

Dedicated to furthering the knowledge, appreciation, and conservation of native plants and habitats of Colorado through education, stewardship, and advocacy

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18TH Annual Colorado Rare Plant Symposium

“Globally Imperiled Plants Found in Southeastern Colorado”

Friday September 10

8:30 AM to 3:30 PM

The Colorado Rare Plant Symposium is held each fall in conjunction with the Colorado Native Plant Society's Annual Conference. Hosted by the Colorado Natural Heritage Program, the symposium is an annual meeting to address current status and conservation needs of rare plants in Colorado. The Symposium will be held in the Pioneer Room at the Sullivan Center of the Trinidad State Junior College. See registration information on page 15 for more details. There will not be a virtual option.

This year's symposium will highlight rare plants of southeast Colorado, including those found in Fishers Peak State Park. Colorado Natural Heritage Program botanist Susan Panjabi will present a photo review of species such as *Asclepias uncialis*, *Frasera coloradensis*, *Herrickia horrida*, *Solidago capulinensis*, and *Oxybaphus rotundifolius*.

Ross McCauley, biology professor and curator of the Fort Lewis College Herbarium, will provide a research update on the diversification and population genetics of rare *Astragalus* in the Four Corners Region.

Jennifer Neale and Michelle DePrenger-Levin, Denver Botanic Gardens, will provide updates on their research and conservation projects including ongoing demographic studies on *Sclerocactus glaucus* and the recently published North American Botanic Garden Strategy for Alpine Plant Conservation.

Jill Handwerk, CNHP, will share images and methods used to survey and monitor the rare endemic *Penstemon debilis* using sUAS (drone) technology.

The results of this work include the identification of several new populations of this rare *Penstemon*.

Jessica Smith will give an introduction on CNHP's new web-based interactive mapping tool, the Colorado Conservation Data Explorer. The CODEX will synthesize sensitive species data from CNHP, Colorado Parks and Wildlife, Bird Conservancy of the Rockies, United States Fish and Wildlife Service, and other related statewide datasets. It is a one-stop shop for Colorado's conservation and natural resources data that allows users to screen a project area for potential impacts to threatened, endangered, and special concern species. CNHP is developing species distribution models for all the SWAP Tier 1 and Tier 2 plants of greatest conservation need for display on the CODEX site, and attendees will have the opportunity to review the models and provide input.

PLEASE REMEMBER TO BRING YOUR VACCINATION CARDS; CARDS WILL BE CHECKED at the door. This is a requirement of the College. Due to the changing situation regarding COVID-19, additional requirements may be necessary as well.

Past presentations and species-specific meeting notes from the 2004-2020 symposia are available on the CNHP website. View or download copies at <https://cnhp.colostate.edu/projects/colorado-rare-plant-symposia/> or view the Colorado rare plant guide here: <https://cnhp.colostate.edu/library/field-guides/> Contact Jill Handwerk for more information at jill.handwerk@colostate.edu 🌀



Frasera coloradensis (Colorado green gentian). © Jill Handwerk



Neal Swayze preparing for *Penstemon debilis* drone surveys at Anvil Points. © Jill Handwerk

45TH Annual CoNPS Conference

“The Short Grass Prairie and a Long Look Back”

Welcome to the 2021 Annual CoNPS Conference, hosted by the Southeast Chapter. This year's conference will be held in Trinidad, CO September 10-12 at the Trinidad State Junior College.

The conference will start with a Friday evening social event, held in the Pioneer Room of the Sullivan Center. This is our time to relax and socialize! Finger foods and non-alcoholic beverage service will be provided with a separate registration fee.

The conference itself will be held in the Scott Gym, where the bookstore, breaks, lunch, and parking are in close proximity to one another. We will be seated in chairs on the covered gym floor and the speakers will be elevated on risers, with a special PA system. Snacks and beverages will be provided at the morning and afternoon breaks. During the breaks, attendees are encouraged to visit the CoNPS on-site bookstore, vote for their favorite photo contest entries, and bid on silent auction items on the CoNPS website. Lunch on Saturday will be provided in the cost of the conference.

Please see page 12 for the detailed agenda and page 15 for registration information.

In addition to the in-person conference, we hope to live-stream the presentations for virtual attendance. Links to all conference recordings will be sent to those who purchase either an in-person ticket or a virtual ticket. Note that it will take some time to edit and upload the recordings before they will become available for viewing.

OF SPECIAL NOTE: If you are attending in person, PLEASE REMEMBER TO BRING YOUR VACCINATION CARD to gain entry into the conference, as dictated by the Las Animas County Board of Health and College regulations. We may also be required to wear masks indoors if the County is still on orange status on Friday and Saturday.

Thanks to all conference committee members whose efforts have made this year's conference possible, and also to the many other involved volunteers.

Speakers and Presentations

(arranged in order of presentations)



Melody Daugherty

Telling the story of the land and its people — Southern Colorado Land Acknowledgement

Melody Daugherty will open our ceremonies with an acknowledgement of the land and indigenous people of southern

Colorado. She has lived life immersed in nature. “Being a Midwesterner at heart, I love walking in big, open fields, laying under massive maple trees or following meandering stream banks barefooted, witnessing how Nature does Nature. I was fortunate enough to have been raised in a rural setting amongst marshes and lakes known as the Kettle Moraine. The peaceful, abundant, deep-greening memories are my taproot.”

Melody Daugherty has worked for many years as a professional gardener, both in the Midwest and in Colorado. She is also active with the Manitou Pollinators, and says the 2018 bee-colony collapse along the Front Range required the group to “walk its talk” and find creative ways to help conserve pollinators in Manitou Springs.

“As an indigenous woman, I have been taught that I have a spiritual obligation to care for all of my relations and the Earth. We know and understand the deep interconnectedness of all of life. We know and understand that being human does not mean we are the center or the focus of this life, and that our needs do not take precedence over other species. Pollinators, like all the other beings, have the same needs for food, shelter, nesting, mating, air, water, and access to their migration routes and territory.”



Erik & Mary Beth Tucker and Steve & Joy Wooten

Telling the story of the land — Ranches of the Southeast

Local ranchers Erik and Mary Beth Tucker and Steve and Joy Wooten will

discuss their relationships to the land, the Sante Fe Trail, and a sustainable vision for grassland management in southeastern Colorado. ►

◀ A cowboy by choice and not by family tradition, Erik Tucker spent many years working in feedlots. He became increasingly aware of how cattle management was really land management. He and his wife bought a ranch in Ordway, Colorado, where they are learning and working to build a sustainable cattle operation. “As a YouTube graduate”, Erik says, “I have been exploring the world of sustainable cattle ranching from the comfort of my home during COVID times.”



As a fourth generation cattle rancher in southeastern Colorado, Steve Wooten, owner of Beatty Canyon Ranch, has been living and working for most of his life on the land that his great grandfather purchased in 1929. Now, joined by both the fifth and sixth generations, Steve has devoted his life to the

proper care of his family, land, and cattle, learning everything he can about anything in between.” From: RiversEdge West, Stewards of the Land: Riverside Stories <https://riversedgewest.org/sites/default/files/files/SteveWooten.pdf>

Alli Schuch and Julie Knudson

Telling the story of the waters — Arkansas River Watershed

Alli Schuch and Julie Knudson, watershed coordinators in southern Colorado, will tell us the story of the Arkansas River Watershed. In southeastern Colorado, we are all connected by the Arkansas River. From Leadville, Colorado, to Arkansas, where the Arkansas River meets the Mississippi River, the Arkansas River nourishes family, farm, and forest. We will learn what a watershed is and how we can get involved in watershed planning and stewardship in Colorado.

Alli Schuch is a watershed-education consultant working on behalf of the Fountain Creek Watershed District. She has been a resident of Colorado Springs for 22 years, with



experiences at the Cheyenne Mountain Zoo, El Paso County (CO) Parks, City of Colorado Springs, and Colorado Springs Utilities. She enjoys gardening, traveling, cooking, and knitting.

Executive Director/Watershed Coordinator Julie Knudson has worked as a land manager and in a variety of



‘ologist’ roles (restoration ecologist, hydrologist, botanist, soil scientist, weed manager, staff scientist, consultant) across the West on rivers and uplands in Colorado, Montana, and Alaska. She has also worked as an educator both in academia and in the community. She has been a dedicated ‘plant nerd’ for many years, including volunteering with the Colorado Native Plant Society, Colorado Natural Heritage Program and Denver Botanic Gardens, and has

spent many many hours in delicious smelling herbariums around the West. She worked with Rocky Mountain National Park and RiversEdgeWest prior to her current role, which now focuses on working with partners across the watershed and region to restore, protect and enhance the Purgatoire River watershed through stakeholder engagement, collaboration, education, and on-the-ground work for the benefit of all. Academic work: PhD Restoration Ecology/Rangeland Ecosystem Science, MS Natural Resource Conservation/Soil Science, BS Biology & Political Science.



Alex Goetz

Research applications — Recovery of Salix Following Tamarix Removal

Removal of invasive *Tamarix* spp. in the American Southwest has had deleterious impacts on habitat availability for the endangered Southwestern

willow flycatcher (*Empidonax extimus trailii*, abbr. SWFL), which nests readily in *Tamarix* when native *Salix* canopy is not present. Understanding the characteristics associated with *Salix* recovery can allow for more-effective targeting of restoration efforts in the context of SWFL conservation. If we can identify conditions leading to more native vegetation cover, as well as provide habitat protection for the SWFL, we can prioritize efforts more effectively and reduce conflict between conservation goals.

Using a multistate data set of *Tamarix* removal sites in three different watersheds, we ask the following questions: (1) Does removal of *Tamarix* lead to the establishment of *Salix*? (2) Which *Tamarix* removal methods have the best outcomes in terms of *Salix* cover? (3) What environmental conditions are required to implement a successful *Salix* restoration effort? We compiled data on vegetation response to *Tamarix* ►

◀ removal, consisting of plant cover, soils, and geographic conditions in riparian areas of the American Southwest.

In total, there were 243 sites where *Tamarix* had been subject to active removal and/or biocontrol, and 172 reference sites. We found that (1) while decreased *Tamarix* cover is associated with an increase in *Salix*, the increase does not compensate for the overall losses in canopy cover. (2) We did not find a significant difference in *Salix* cover among *Tamarix* removal methods or relative to negative reference sites; however, sites where herbicide was applied at any point had higher *Salix* cover. (3) We found significant impacts of several environmental characteristics, including soil properties, distance to water, and initial *Salix* cover. Our data reflect the fact that *Salix* and *Tamarix* occupy distinct environmental niches. Our findings suggest that *Tamarix* removal does not necessarily lead to favorable outcomes for SWFL conservation but that outcomes can be improved by focusing on sites more likely to promote *Salix* growth based on environmental characteristics.

Alex joined Dr. Anna Sher's lab at Denver University as a PhD student in the fall of 2018. His research focuses on the impacts of riparian restoration and Tamarix removal on plant communities. He assisted with the lab's 2020 paper on the human dimension of restoration, and current projects include a study on regeneration of Salix trees following Tamarix removal as well as a broad-scale meta-analysis of Tamarix-removal outcomes.

Susan Carter, Deryn Davidson, and Irene Shonle

Preserving the knowledge, educating the next generation — CSU Extension Native Plant Master Program

Colorado has a wealth of native plants, colorful wildflowers, grasses, shrubs, and trees which are naturally adapted to our variable climate, soils, temperatures, and elevations. Native plants are great for landscaping because of their adaptability. The Colorado Native Plant Master Program is a tried-and-true way to learn about native plants, sustainable landscaping, and invasive weeds. In this talk, Irene Shonle, Susan Carter, and Deryn Davidson, Colorado State University extension agents, will describe the Native Plant Master Program. Dr. Shonle will address efforts to revive the NPM program in El Paso County in partnership with the CoNPS southeast chapter. (<http://conativeplantmaster.colostate.edu/>)



Susan Carter started with CSU Extension in early 2014. Susan is the horticulture and natural resource agent for Colorado State University Extension, Tri River Area, covering Mesa, Delta, Montrose, and Ouray Counties. She was a native plant teaching assistant while working on her master's degree in landscape architecture. Susan has always had a love for native plants, having worked at several nurseries that sold many native plants. She loves teaching CSU Extension Native Plant Master classes at three different western Colorado sites. Susan hosted the 2019 CoNPS Annual Meeting in Grand Junction and oversees the Ute Ethno-Botanical Learning Garden, which consists of native plants.



Deryn Davidson is the horticulture extension agent for Colorado State University Extension in Boulder County. Deryn has a demonstrated history of working in the higher-education industry and providing outreach and education to Coloradans. Horticulture skills focus on native plants, water conservation, pollinator habitat, and design.



Irene Shonle, PhD has supported native plants in Colorado for more than 20 years. Among other accomplishments, Irene has worked with Colorado State University Extension since 2002, is a former CoNPS board vice president, has taught about native plants around the state, and is on the planning committee for the Landscaping with Colorado Native Plants Conference. ►



◀ **Chrissy Alba**
Research applications
— Natural History
Collections at the
Nexus of Past and
Future: How Floristic
Inventories Can Spur
Successful Ecological
Research on the
Eastern Plains

In this time of rapid environmental change, how can we improve our sampling of plant biodiversity and, by extension, our understanding of plant-community dynamics? Dr. Alba will explore how combining sampling approaches from floristic botany and ecology can help us better understand key phenomena, such as grazing, drought, and varying edaphic factors shaping plant communities on the Eastern Plains.

While plant biodiversity is a concept we all intuitively understand and value, it is actually a difficult thing to measure. Given that we are in an age of rapid biodiversity loss, it is time to thoughtfully combine sampling approaches from different disciplines to create new insights. In particular, we must first thoroughly document floristic patterns (which species exist in an area?) before we can then go on to describe ecological processes (why do species and communities exist as they do?).

Floristic botanists often use collections-based approaches to elucidate biodiversity patterns, while plant ecologists use hypothesis-driven statistical approaches to describe underlying processes. Each approach has its strengths, and, when used together, they give a more thorough picture of plant community dynamics. In this talk, Dr. Alba will illustrate how using these complementary approaches can generate a better understanding of how phenomena like grazing, drought, and varying edaphic factors shape plant communities on the Eastern Plains. She will highlight some beautiful locations in southeastern Colorado (undersampled from a collections standpoint) where Denver Botanic Gardens has had the opportunity to sample.

Chrissy Alba, PhD, studies the ecological and evolutionary processes that shape plant diversity and distributions across various scales of organization—from individual plants to populations, and to entire communities. She has studied how biological invasions, grazing, climate change, fire, and rapid adaptation to novel environments affect plant biodiversity. At Denver Botanic Gardens, she combines complementary sampling approaches from different disciplines—including collections-based botanical floristics and quantitative plant ecology—to improve our understanding of what factors shape plant biodiversity.



Jennifer Ackerfield
Preserving the
knowledge, taxonomy
updates — Second
Edition Updates to
Flora of Colorado

Dr. Ackerfield is currently working on a second edition for the *Flora of Colorado*. She will engage

us with an interactive presentation on what is changing, what is not, new tools that will be included for identification, and how to contribute new species-distribution data through iNaturalist.

As the head curator of natural-history collections and the associate director of biodiversity research, Dr. Ackerfield coordinates the growth, improvement, and support of Denver Botanic Gardens' biodiversity-research efforts. Natural-history collections are moments in time, and as such they represent invaluable sources of material for biodiversity, ecology, evolutionary, systematic, and climatic studies.

Jennifer Ackerfield, PhD, coordinates and leads fieldwork to floristically interesting or undercollected areas to document and catalog the rich biodiversity in Colorado and the Southern Rocky Mountains. These collections also help build upon the Flora of Colorado, the most current and comprehensive guide to the flora of the region, which she authored in 2015. In addition, she develops research projects that complement and enhance the existing research at the gardens as well as incorporate natural history collections.

*Jennifer is currently involved in research she terms "a prickly puzzle," which aims to identify the evolutionary, biogeographical, and ecological patterns that underlie diversification, speciation, and trait evolution in the thistles (*Cirsium* spp.) of North America.*

Lastly, she provides outreach for the gardens by actively connecting members of the community to biodiversity and natural-history collections through citizen science campaigns, speaking engagements, and workshops.



Amy Yarger and
Melody Daugherty
Engaging the
community for our
ecological future
together — Pollinator
Districts

From large agricultural crops to local vegetable gardens, pollinators are vital to the human

production of food sources and the reproduction of ►

◀ native plants. However, pollinators are in crisis. Over the past few decades, there has been significant global loss in pollinators, including honeybees, native bees, and butterflies, due to habitat destruction, chemical pollution, parasites, and pathogens.

In response to these challenges, Butterfly Pavilion is lending its unique expertise to create Pollinator Districts, or communities committed to conserving and improving habitat for pollinators in all aspects of development and operation. Pollinator Districts engage all of the people who live, work, and play in these spaces, encouraging them to experience nature and build a greater appreciation for these critical species and their habitats.

While Amy will help us understand the pollinator district program at large, Melody will give an account of her experience launching a pollinator district in Manitou Springs, Colorado. Melody will also speak to the connections between indigenous people and pollinators.

In her role as horticulture director at Butterfly Pavilion, Amy Yarger curates tropical and outdoor garden collections for an AZA-accredited invertebrate zoo. She also spearheads community conservation programs, such as the Urban



Prairies Project, and leads sustainability efforts at Butterfly Pavilion. Her interests include ecosystem gardening, open-space preservation, science education, and community design and engagement.

See the opening presentation on page 5 for Melody Daugherty's biography.

Paul Alaback and Ann Grant

Engaging the community with scientific pursuits — BudBurst/CoNPS Citizen Science

Project BudBurst is a national field campaign designed to engage the public in collecting data about plant phenology. Participants make careful observations of phenological events, such as the emergence of first leaves, first flowers, and first ripe fruit for a diversity of species. BudBurst projects allow community scientists to collect, archive, and freely share both long-term data to be used by the scientific community and short-term data pertaining to specific, time-bound research questions that we will analyze and report on <https://budburst.org/plants-climate-change>.

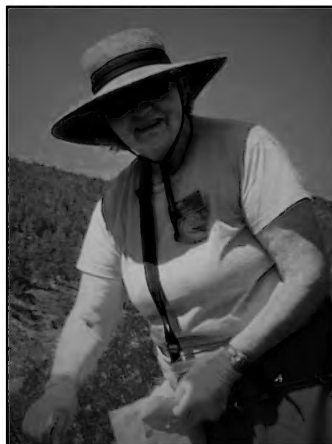
Dr. Alaback will introduce the audience to Project BudBurst. Ann Grant, CoNPS Northern Chapter Chair, will present the CoNPS citizen science campaign

initiated in COVID times and currently in its pilot field season. BudBurst presents a unique opportunity for CoNPS members to deepen their involvement in the research applications of simple botanical observations. This research is extremely important to our current and future understanding of how plants respond to climate change.



Paul Alaback, PhD, is professor emeritus of ecology at the University of Montana and has been teaching and conducting research on the ecology of forests, grasslands, and natural disturbances for more than 30 years. He was one of the scientists involved in establishing the nationwide

citizen science BudBurst program in 2007. Paul has also authored or coauthored several plant field guides, including Wildflowers and Other Plants of the Larimer County Foothills Region.



Ann Grant is a member of the CoNPS board and is on the operating committee. She moved to Colorado in 1997 from the East Coast and ran a propagating nursery in Fort Collins for 13 years, where she taught herself how to grow native plants from seeds and cuttings. She is also chair of the horticulture committee and a Native Plant Master instructor. Her current interests include gardening with natives and phenology of

native plants. She is co-leading a phenology project with Kathleen Maher and Paul Alaback at River's Edge Natural Area in Loveland. She has recently moved to Loveland and is happily converting her yard to native-plant and veggie gardens.



Maggie Gaddis

Research applications — Active Revegetation in the Garden of the Gods with Native Species, Citizen Scientists, and No Supplemental Water

Citizen scientists can support a sustainable system for monitoring land stewardship and restoration activities by engaging adult volunteers in the measurement of ecological parameters over time. Rocky Mountain Field ►

◀ Institute was the first nonprofit organization in the Colorado Springs area to train and engage citizen scientists. The training model for the program provided an innovative example for other organizations and agencies interested in monitoring natural lands. From 2016 to 2019, RMFI citizen scientists collected data on trails in the Garden of the Gods, Colorado Springs. Citizen scientists conducted human behavior monitoring to characterize closed-trail compliance. They measured trail-shape dynamics before and after trail-improvement projects, and measured vegetation dynamics on actively restored closed social trails. This research informs Garden of the Gods land managers and managers of similar ecosystems, and it provides scholarly engagement for citizen scientists, who are undergraduate and graduate students and local residents. One of the most important results to communicate involved the successful active revegetation of native grasses without supplemental water. Closed trails saw a 40–70 percent total plant cover increase throughout the

measurement period, despite no supplemental water in the restoration year and no subsequent water or maintenance over time. In addition to a discussion of the asynchronous remote training design, details of these botanical research findings will be shared with insights for future projects.

Maggie Gaddis, PhD, currently teaches biology, resource management, and conservation and sustainability courses at the University of Colorado–Colorado Springs. She is also a member of the Bard College Citizen Science faculty. Maggie engages citizen scientists and students to develop monitoring programs that measure ecological-restoration projects in natural land settings where anthropogenic environmental degradation exists. She is also interested in the relationship between training design and the reliability of data collected by citizen scientists. Of special note, she will start as CoNPS's first executive director on September 1. For fun, Maggie volunteers as the CoNPS Southeast Chapter president, gardens with her family, recreates in public lands, and spends as many hours as possible on a paddleboard listening to audio books. 🌀

Field Trips

Please consider joining your fellow members on one of the trips exploring the natural habitats around the Trinidad area. Our trip leaders put time and effort into their presentations, and we aim to have a minimum of six participants taking part in each outing. Because this year's meeting is not located near the center of our membership distribution, and field-trip participants may want to head home at a reasonable hour, we have planned for early start times. Details on where to meet are on the CoNPS calendar of events for September 12 and will also be provided at the conference.

Fisher's Peak SP

We have access to two miles of open trails at Colorado's newest state park. There is a good representation of the area's vegetation up the slope heading toward the peak. Alas, the peak itself is not yet accessible, nor are areas of greater diversity within the park, but they will be in the future. There are open juniper woodlands at the

base, and pinyon to be seen up the slope. The trail is relatively flat for the first half-mile, but then gains almost 900 feet in the last mile.

Long's Canyon, Trinidad Lake SP

The Long's Canyon Trail meanders through an open creek bottom at the head of Trinidad Lake. It is mostly grassland vegetation with scattered junipers and willow, with cottonwood near the creek. Open pinyon-juniper woodlands are on the higher surrounding terrain. Notable here is an exposure of the K-T boundary, showing when dinosaurs met their end. The

Long's Canyon field trip will include one and a half to two hours on the ground. The trail is less than a mile long, but exploring the surrounding area can be quite interesting.

Cordova Pass

The 44-mile trip on the Highway of Legends goes through lots of southern Colorado scenery for those wishing to take ►



Fisher's Peak State Park from the Long Trail to the Viewpoint
© Mo Ewing

◀ their time on the way home. The destination is the John B. Farley Wildflower Overlook Memorial on the edge of Huerfano County. There are subalpine meadows to explore, along with the adjacent aspen and spruce forests. There are good views of the Culebra Range, and it's just a short way to see the Spanish Peaks.

North Fork Purgatoire

This trip begins with an inspiring 35-mile drive on the Highway of Legends with lots of southern Colorado scenery. It would be good for anyone wanting a scenic ride back to the north. We will go along the North Fork Purgatoire River through the North Fork State Wildlife Area and parts of the San Isabel National Forest. We will make several stops to explore different vegetation types, including riparian aspen stands, willow carrs, and ponderosa pine woodlands.

Depending on participation, the North Fork Purgatoire River and Cordova Pass trips may be combined. This is predominantly a scenic drive to get to the sites, but there will be opportunities at the destinations to wander around and look at the local flora. Drive time to the sites is about an hour, and we can spend as much time as needed at each destination. Since these are generally north of Trinidad, folks may depart on their own timetable.

Reilly Canyon

The Reilly Canyon Trail traverses a ridge above the north shore of Trinidad Lake. It goes through foothills grasslands intermixed with pinyon-juniper woodlands. The grassland diversity is quite good. This trail is a bit over four miles long from trailhead to trailhead. This is likely to be our longest trip of the day for those who want to walk through the southern Colorado hills. Of course, if we have some serious hikers, they could do the nine-mile round trip.

Nature Journaling at Wormhole Loop Trail — with Dina Baker and Kimberly Rose

We will be combining scientific observation and artistic skills in order to improve our nature-journaling abilities. This workshop will consist of a few drawing lessons, nature explorations, and mindfulness invitations as well as individual time to practice journaling. We will also examine plants, observe wildlife, and use as many of our senses as we can. Nature journaling offers so many benefits, including improving observational skills, increasing awareness, offering opportunities to de-stress, improving plant and animal identification, and deepening our connection to the natural world. The parking lot for the Wormhole Loop Trail is at the curve of County Rd 69.4 (<https://mapcarta.com/N6400942661>).



Dina Baker runs her own nature-inspired art gallery, studio, and educational programs in Conifer called the Nature Link. Kimberly Rose runs her own nature guiding and nature-based therapy business called Relational Rewilding. Both have Native Plant Master and Audubon Naturalist certifications.

Ethnobotany of the Spanish Peaks Region — A guided walk studying the edible, medicinal, and useful wild plants of south-central Colorado with Bob Kennemer

The unspoiled wild lands of the Spanish Peaks region provide a rich resource for the study of wild plants used by humans who resided in the area, including indigenous peoples, early Spanish settlers, and European settlers. On this outing, we discuss folk and traditional uses of these plants as well as current research. We will also review dangerous and poisonous plants as we come across them. Being in a state park, we cannot harvest plants in quantity; however, the picking and use of sample plants will be allowed for this hands-on session. Handouts and a bibliography will be provided. Dress and be prepared for a gentle outdoor hike.

Bob Kennemer hails from the Denver area, where he majored in environmental science and education at the University of Denver. Bob went on to study at the National Outdoor Leadership School in Lander, Wyoming, where he was certified as an Outdoor Leader. Bob has worked as a professional outdoor guide and environmental educator for more than 40 years. A resident of La Veta, Colorado for the past 35 years, Bob has studied nature, the wildlife, and the wild plants of the region, as he often worked as an environmental interpreter and naturalist for state parks. Bob also provides programs on wildlife safety, a snake safety program called "Rattlesnakes – No Bull!", wild mushrooms, and numerous other topics. Additionally, Bob is a history buff. He was the director at Francisco Fort Museum in La Veta for five years; his knowledge of local history is strong, and he is active in local and regional historical groups. Bob sits on several local and regional boards related to sustainable tourism and economic development. He is the current president of the Scenic Highway of Legends. 🌀

Conference Agenda

Friday, September 10

8:00 AM to 3:30 PM: Rare Plant Symposium in the Pioneer Room at the Sullivan Center

5:00 PM to 8:00 PM: Friday Night Social in the Pioneer Room at the Sullivan Center

Saturday, September 11

8:00 AM to 5:00 PM: CoNPS Annual Conference in Scotts Gym at Trinidad State Junior College

Time	Description	Speaker
8:00 AM	Attendee check-in/registration, on-site Bookstore, Photo Contest and Silent Auction viewing	
9:00 AM	Welcome	Maggie Gaddis, CoNPS Executive Director
9:10 AM	<i>Telling the story of the land and its people</i> Southern Colorado Land Acknowledgement	Melody Daugherty
9:20 AM	<i>Telling the story of the land</i> Ranches of Southeastern Colorado	Eric & Mary Beth Tucker, Ordway, CO Steve & Joy Wooten, Kim, CO
10:00 AM	<i>Telling the story of the waters</i> Arkansas River Watershed	Alli Schuch and Julie Knudson
10:30 AM	Break	
10:50 AM	<i>Research applications</i> Recovery of <i>Salix</i> Following <i>Tamarix</i> Removal	Alex Goetz
11:10 AM	<i>Preserving the knowledge, educating the next generation</i> CSU Extension Native Plant Master Program	Susan Carter, Deryn Davidson, Irene Shonle
11:40 AM	<i>Research applications</i> —Natural History Collections at the Nexus of Past and Future: How Floristic Inventories Can Spur Successful Ecological Research on the Eastern Plains	Chrissy Alba
12:10 PM	Lunch	
1:40 PM	<i>Preserving the knowledge, taxonomy updates</i> Second Edition Updates to <i>Flora of Colorado</i>	Jennifer Ackerfield
2:10 PM	Volunteer Appreciation	Denise Wilson
2:40 PM	<i>Engaging the community for our ecological future together</i> Pollinator Districts	Amy Yarger, Melody Daugherty
3:10 PM	Break	
3:30 PM	<i>Engaging the community with scientific pursuits</i> Budburst/CoNPS Citizen Science	Ann Grant, Paul Alaback
4:00 PM	<i>Research applications</i> Active Revegetation in the Garden of the Gods with Native Species, Citizen Scientists, and No Supplemental Water	Maggie Gaddis
4:30 PM	Closing Remarks	
4:45 PM	Field Trips Announcements	Steve Olson

Sunday, September 12

8:00 AM: Field trips. Meetup locations will be provided at the conference on Saturday.

Fishers Peak State Park — two or more groups
Long's Canyon at Trinidad Lake State Park
Cordova Pass
Nature Journaling at Worm Hole Loop

Reilly Canyon at Trinidad Lake State Park
North Fork Purgatoire
Ethnobotany of the Spanish Peaks Region

Annual Silent Auction Benefits CoNPS Activities

We will be holding the auction online again this year and ask you to donate NOW! Donors should send photos, descriptions, original cost, and value of items to Denise Wilson, deniseclairewilson@gmail.com or Sue Dingwell, sageblue892@gmail.com

Our auction site, 32Auctions, will be opened for preview on August 25, at this link:
<https://www.32auctions.com/CoNPS2021>

Click "VIEW ALL ITEMS" directly under our CoNPS logo. In yellow banner across top of next page see "LOG IN or CREATE ACCOUNT." Create Account (name, email, password) the first time you access the site; after that, just log in. A display name instead of your real name can be set if desired. You will receive confirmation of your bids by email from 32Auctions.

Bidding runs from August 30 - September 12, the last day of the conference.

New items can be added at any time! Maybe you DO have something to donate!

Annual Photo Contest Call for Entries

Share your spectacular photos of native plants and scenery in our Annual Photo Contest! We know you have some! Your favorite photos from any year are eligible, you may submit one photo in each of five categories, listed below.

1. Colorado Native **Plants**
2. Colorado Native Plant **Landscapes**
3. Native Plant **Gardens**
4. Colorado Native Plants and **Wildlife**
5. **Artistic** interpretation of Colorado Native Plants.
Artists are welcome! Photo of a fine art painting or an altered photograph or collage are acceptable.
Must be a recognizable Colorado native plant.
Submit your entries online at <https://woobox.com/rof6cs>

Entries must be a single work of original material submitted by the contest entrant.

Submissions accepted through midnight September 4. A \$50 prize will be awarded to the entry receiving the most votes in each category. Voting will be online beginning on September 5 and ending at 2:30 pm September 11. Contest winning entries and other entries will be presented at the conference on September 11. Contest is open to all CoNPS members. Questions? Email to Bruce Tohill, tohillb@msn.com

Volunteers Needed for the Annual Conference

We will need volunteers for a variety of jobs at the conference. Please contact: Denise Wilson at deniseclairewilson@gmail.com

In addition, are you willing to write a summary of one or two of the presentations from the Annual Conference? If so, please contact Kelly Ambler (alpineflowerchild@gmail.com) or Gayle Hemenway (gayladamato@gmail.com).

This year, we are acknowledging our terrific and generous CoNPS volunteers at the annual conference!

If you are a CoNPS volunteer, please upload your picture, name, chapter, and list the events and other roles you have undertaken with CoNPS.

https://docs.google.com/presentation/d/1fawBRzoDF1v_xPOPInmALic7IS8lleGAAlhcWtEJf_Y/edit?usp=sharing

Please Consider Sponsoring the Colorado Native Plant Society 45th Annual Conference

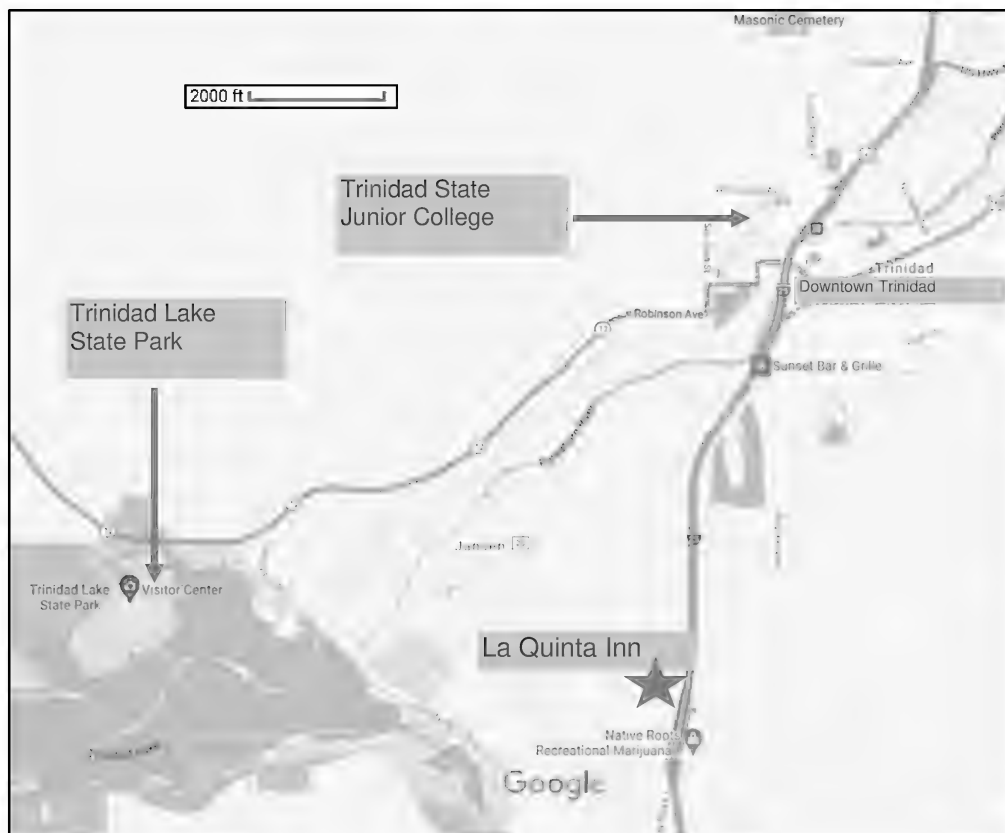
Daisy Level - \$50 gets your name and logo in the Conference Agenda, in the *Aquilegia* issue summarizing the Conference, and in the eNews, our bi-monthly electronic newsletter.

Golden Banner Level - \$100 gets ALL of the above acknowledgements plus acknowledgement in the *Aquilegia* Magazine for one year (four issues).

Columbine Level - \$250 or more gets ALL of the above acknowledgements, plus your logo and name on the Home page of the CoNPS.org website for one year.

Wood Lily Level - \$500 or more gets ALL of the above acknowledgements, plus a booth/table at the Rare Plant Symposium on Friday, September 10, the Social afterward, and at the conference in Scotts Gym on Saturday, September 11.

Trinidad Area Maps and Information



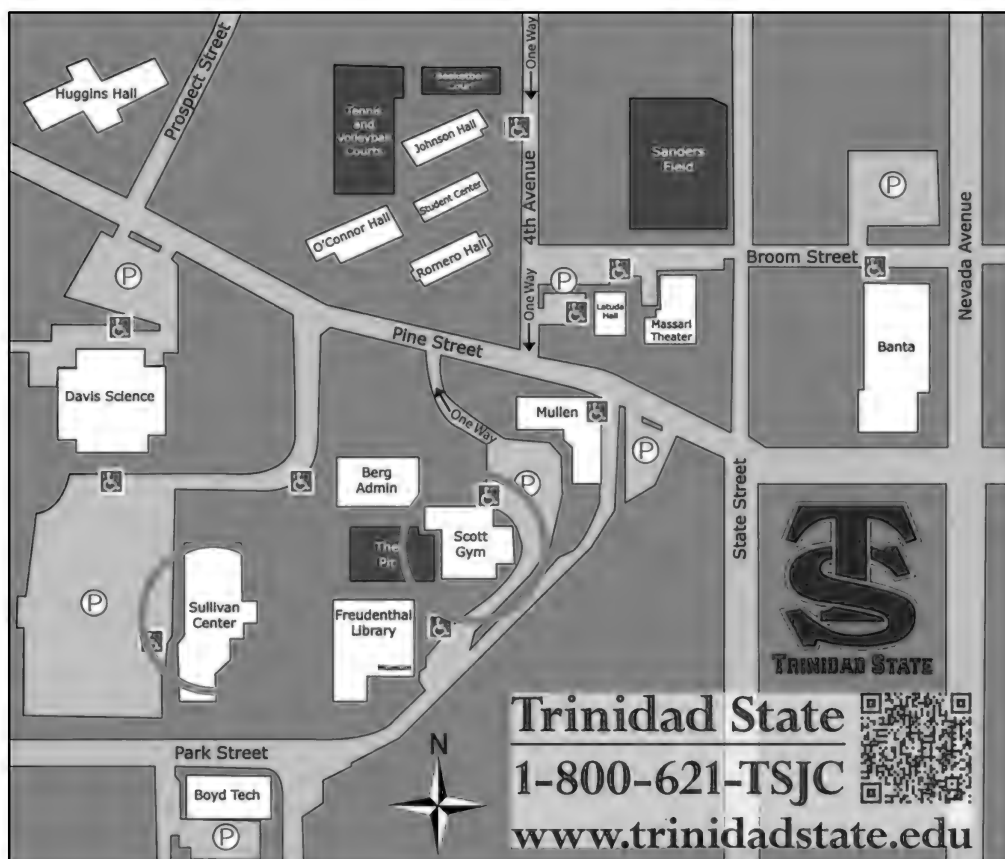
Average daily high temperatures in Trinidad decrease from 81°F at the beginning of September to 73°F by the end of the month and rarely fall below 62°F or exceed 88°F. Daily low temperatures at the beginning of September are 55°F, with an average low of 45°F by the end of the month and rarely fall below 36°F or exceed 60°F.

Housing

We have a block of rooms reserved at La Quinta Inn until August 20 for a discounted rate of \$119/night pre-tax for a standard double room. Call 719-845-0102 and ask for Yvette, and tell her you are with the Colorado Native Plant Society. Hold your reservation with a credit card; free cancellation 3 weeks prior to occupancy. See the CoNPS website for additional housing and camping options (<https://conps.org/wp-content/uploads/2021/07/2021-lodging.pdf>).

Camping

Several members will be camping at the Trinidad Lake State Park Campground. At press time, there were not any more campsites available during the conference dates. However, we have several campsites which can be shared, with a limit of two tents per site. Contact Denise at deniseclairewilson@gmail.com if you are interested in sharing a campsite. Note that Trinidad Lake State Park requires a daily park pass or a valid state parks pass.



Registration

Registration is available online at <http://conps.org> through September 7. Please log in if you are a CoNPS member, then proceed to the Calendar of Events to register. **Note: attendees MUST SHOW PROOF OF VACCINATION**, per county health directives. Face masks may also be required.

If registering by mail, please complete the following registration form for each person attending and post in the mail by August 31. Mail registration form and payment to:

CoNPS, c/o Linda Smith, 4057 Cottonwood Dr., Loveland, CO 80538

Name (first, last) _____

Phone _____ **Email** _____

Mailing address _____

Registration fees include attendance to the Annual Conference on Saturday, September 11, a box lunch and snacks on Saturday, and the Sunday field trip of your choice. There is no price reduction when opting out of the box lunch. Separate fees are charged for attending the Rare Plant Symposium or the Friday Night Social.

Member registration*

The 18 TH Annual Rare Plant Symposium @ \$15	\$ _____
The 45 TH Annual Conference	\$ _____
Regular registration @ \$65 (\$75 after September 9)	\$ _____
Student registration @ \$30	\$ _____
Virtual option only @ \$25	\$ _____
Friday Night Social @ \$10	\$ _____
Total enclosed	\$ _____

Non-member registration* Consider becoming a member! See page 42

The 18 TH Annual Rare Plant Symposium @ \$15	\$ _____
The 45 TH Annual Conference	\$ _____
Regular registration @ \$75 (\$85 after September 9)	\$ _____
Student registration @ \$40	\$ _____
Virtual option only @ \$35	\$ _____
Friday Night Social @ \$10	\$ _____
Total enclosed	\$ _____

* A limited number of scholarships are available. See CoNPS.org for details.

Lunch options, choose one:

- ☐ Roast beef and cheddar (medium-rare roast beef and mild cheddar, leaf lettuce, and tomato on a ciabatta roll topped with a tangy horseradish cream spread)
- ☐ Tuscan grilled chicken sandwich (balsamic-coated grilled chicken, with fat-free hummus, bistro sauce, roasted onions, and peppers on a multigrain roll)
- ☐ Mediterranean veggie wrap (grilled eggplant with fresh cucumbers, peppers, lentils, and shallots in a whole grain tortilla with tzatziki sauce and feta (vegetarian))
- ☐ Greek salad (classic Greek salad of firm tomatoes, cucumbers, red onion, kalamata olives, and feta, drizzled with a lite vinaigrette (vegetarian, gluten-free))

All Box Lunches include a bag of chips, pasta salad, a brownie, and a drink. Drinks include bottled water, assorted canned soft drinks, or bottled unsweet tea.

Field Trip Options

Please indicate first and second choices for Sunday Field Trips (included in registration), assigned on first come, first served basis.

_____ Fishers Peak _____ Long's Canyon _____ Cordova Pass _____ North Fork Purgatoire
 _____ Reilley Canyon _____ Nature Journaling at Trinidad Lake State _____ Ethnobotany

☐ Please check if you would like to be contacted about carpooling to Trinidad. If checked, your phone/email information will be provided to others interested in carpooling.

Featured Story

Grassland Ecology and Species Identification

By Maggie Gaddis

Here in Colorado, our joy as botanists is elevational—we have more than 11,000 feet of elevation change within our landscape. Our landscapes represent a beautiful struggle and result in diversity due to elevation variation. In this article, we will explore the lowest elevations of Colorado to ponder the nature of grassy ecosystems in the plains and foothills life zones. These life zones will be the focus of the 2021 CoNPS Annual Conference, planned for September 10–12, in Trinidad, Colorado.

Part 1: Grassland Ecology

Defining Ecology

Before we embark on an exploration of the grasses of Colorado, take a moment to consider your definition of ecology. Then keep reading.

A common definition for ecology is *the study of how organisms interact with their environment*. I don't mind this definition, but it sets up a dichotomy that is not an accurate representation of the science. It suggests we view the environment as a static system and that organisms are reacting to it, but there are organisms in the environment. Therefore, I prefer this definition: *Ecology is the interaction between abiotic and biotic factors in the environment*. Abiotic factors are nonliving components of the environment. Biotic factors are living components of the environment.

Let's look at the image in Figure 1. What are the abiotic and biotic factors? Starting with the abiotic factors, when I look at this picture, I first notice the

ominous clouds, which represent a building of moisture. This moisture is collecting as the clouds are forced to gain elevation to cross over mountain ranges. This historically results in an afternoon thunderstorm.

The next thing I notice is the river. The landscape is rather flat. The river is sinuous. It is a free-flowing river. I can see that the river is wide. It is probably a second-order stream; primary-order streams are smaller and exist in the top of watersheds. There are other abiotic factors that we cannot see here, like the soils and geology of the landscape.

Now, thinking about the biotic factors present in the photo, we find a lot happening. We have two life zones in the picture. In the foreground, we have grasslands; in the background, we have riparian habitat. This is the Arkansas River in Johnson Village, Chaffee County, Colorado at 7,850 feet of elevation.

Along the far bank of the river, we see a forest of trees. These are cottonwoods (*Populus angustifolia* or *balsamifera*). Cottonwoods are the only tree native to the grasslands of Colorado. In the middle ground, we see a bright green swath of manicured grass. This is a cow pasture that looks like a monoculture. Then, in the foreground, we see a wilder-looking area of grass with more heterogeneity. You can see that there is a railbed separating the grass types and representing a kind of anthropogenic boundary within the ecosystem.

Again, ecology is the interaction between the living and nonliving factors in the environment. When you look at a landscape, or an image of one, start teasing out these various factors to understand the advantages and stresses within the environment you see. Certain ecological characteristics typify the grassland ecosystem. Let's explore these.

Abiotic Factors

Grasslands typically have mild slopes, lots of solar radiation, and wild swings in temperature. The latter detail applies to all life zones in Colorado due to our elevation, but the effects are extreme in grasslands. The average rainfall is a parsimonious 12–15 inches per year. This rain falls in a punctuated fashion, sometimes leaving the landscape drought-stricken for months at a time or flooded for 20 minutes and parched for the rest of the day. Grasslands can be frozen and thawed several times throughout a winter, ►



Figure 1. The Arkansas River in Buena Vista, CO.
© Maggie Gaddis

◀ depending on the weather. Some of the harshest environmental conditions on Earth occur in grasslands.

Limestone basement rock is an abiotic element prevalent in Colorado grasslands. This gives rise to slightly alkaline, fine- to medium-textured soils. Fire is another important abiotic factor in grasslands. Fire promotes nutrient cycling. Woody fuels are reduced with frequent, low-intensity fires. This makes the grassland more resistant to devastating, high-intensity fires that kill plants rather than renewing them. Despite these ecosystem services provided by fire, suppression of fire by humans is common in grasslands due to agricultural pursuits or proximity to human development. One indication of a grassland ecosystem lacking historic fire regimens is the abundance of woody plant materials like sagebrush and yucca.

Biotic Factors

Let's begin our discussion of the living members of this ecosystem with the plants for which it is named. Grasses are fierce survivors, enduring some of the harshest environmental conditions on the planet. Grasses have jointed, hollow stems and clusters of small membranous flowers arranged in stems. Grasses have fibrous roots, low lignin content, and annual leaves. These plant characteristics result in substantially more organic-matter development in Colorado grasslands relative to other Colorado life zones, where conifers dominate the vegetative cover or steep slopes erode soils.

Grasses can be perennial or annual. Most Colorado native grasses are perennial. Some are bunchgrasses and others form turfgrass by extending stolons (aboveground) or rhizomes (belowground). Some exotic plants found in the grassland are annual, such as cheatgrass (*Bromus tectorum*).

Grasses have a fibrous root system with lots of surface area that allows them to take advantage of ephemeral precipitation when it comes, sometimes in deluges but not always regularly. In contrast, a taproot is a different evolutionary adaptation for storing water. Some of the many forbs growing in grasslands possess taproots and are perennial, biennial, or annual.

In addition to flowers and grasses, grasslands may

contain woody shrubs. The only trees of grasslands live in riparian zones that weave through the landscape. The biotic factors also include animals. Historically, the primary ecosystem managers were bison, which are now absent from most grasslands. Bison herds were once enormous groups of grazers that moved across the landscape without residing in a single pasture for too long. The action of hooves, grazing, and defecation all contributed to grassland renewal. We might wonder, are cows a good substitute for bison? Rotational grazing, fallowing, and till reduction can mimic the ecosystem services provided by bison and contribute to sustainable cattle grazing.

Principles of sustainable pasture management are based on how much aboveground plant matter is removed during the grazing period. When 90 percent of a grass plant is consumed by the grazers, 100 percent of the roots stop growing for 17 days. When 70 percent of a grass plant is consumed, 50 percent of the roots stop growing for 17 days. And when grazers consume only 50 percent of the available plant matter, the roots do not stop growing at all (Crider 1955). Grazing can stimulate root growth, increasing the vigor of the grassland. In other words, grasses have evolved with grazing. If grazing is absent from a grassland ecosystem, the vigor of the grasses declines over time. Awareness of these ecological relationships has given rise to management-intensive grazing (MiG), rather than intensive pasture use (Gerrish & Ohlenbusch 1998; Shawver et al 2020). In addition to large mammals like bison and cattle in the grassland, there are myriad other animals there, including bears, dogs, reptiles, and birds. Small mammals in the grassland provide numerous

ecosystem services. They assist with the mechanical breakdown of carboniferous material, insect control, and seed dispersal. And they provide food for raptors. Grasslands abound with Insectivora (shrews, moles), Chiroptera (bats), and Rodentia (gophers, mice, prairie dogs, rats, squirrels, voles) (Siemers et al., 2003). The most abundant animals on grasslands are invertebrates, which make up more than 97 percent of the animal kingdom, according to most ▶

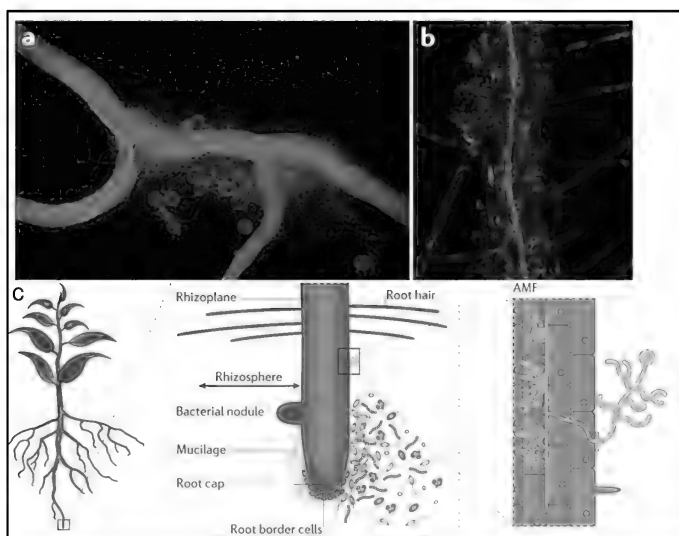


Figure 2. The rhizosphere is a complex ecosystem near plant roots. a. Mycorrhizal hyphae and spores on a corn root. b. Plant growth promoting bacteria (PGB) on Arabidopsis roots. c. Rhizosphere schematic. Image from: Philippot, L et al. (2013).

◀ estimates, including the Center for Biological Diversity.

I previously characterized soil as an abiotic factor, based on its mineral characteristics, but soil is also alive with microbiota. The near-root environment is called the rhizosphere (Figure 2). Soil contains the chemical constituents of the species living in it. Soil macroinvertebrates and microorganisms facilitate decomposition and nutrient cycling. Soil also contains fungi, which facilitate decomposition and water absorption. Of great importance to the grassland ecosystem are mycorrhizae, soil fungi that play a critical role in primary production in grasslands. All fungi are heterotrophs and therefore cannot produce food on their own. The relationship between soil fungi and plants is mutually beneficial. Mycorrhizae vastly extend the surface area of the fibrous roots of grasses. This increases water absorption and nutrient exchange to the benefit of both the fungi and plants. We also find that the rhizosphere contains abundant bacteria that convert and assimilate chemicals for plants to take up (Volder, 2016).

In this ecological journey through the grassland ecosystem, we see the interactions between abiotic and biotic components of the environment. The abiotic environment is characterized by climate, aspect, slope, and geology. The biotic environment contains species in every kingdom of life on planet Earth. Although grasses might be the poster child for the grasslands, they are only a single player in a complex ecosystem.

Part 2: Native-grass species identification

Here we explore 11 common grass species in Colorado and in the Great Plains of the United States. I am an ecologist, not a botanist. Knowing the plants is a matter of knowing their niche in the ecosystem. My commitment to CoNPS is a selfish one; I need more botanists in my life so that I can be a more successful

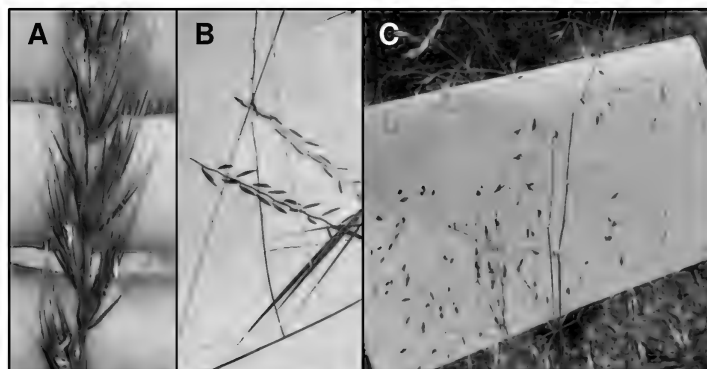


Figure 4. The inflorescence of (A) *Nassella viridula* is a spike; that of (B) *Bouteloua curtipendula* is a raceme, and that of (C) *Achnatherum hymenoides* is a panicle.
© Maggie Gaddis

restoration ecologist. When I shifted my research ecosystem from riparian to grassland, I needed help learning all the grasses. What follows is a result of my continued engagement in CoNPS activities. Please excuse any descriptions that may lack the technical detail some readers desire. This is how I identify these grasses based on their appearance and stature.

There are two parts of grasses that I find most helpful in grass identification. The first is the ligule, a membranous scale between the sheath and the stem (Figure 3). It can be papery or hairy. The inflorescence is also important (Figure 4). A spike is a seedhead in which one or more sessile spikelets are borne on the main axis (rachis). A raceme is a seedhead in which the spikelets are borne on individual footstalks (pedicels) growing directly on the rachis. A panicle is a seedhead with a main axis and subdivided branches. It may be compact and spikelike, or open.

The following pages describe some of our more common shortgrass prairie grasses. Specific identifying characteristics are discussed.

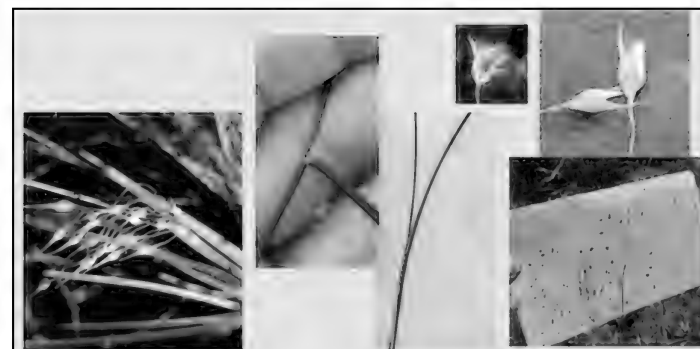


Figure 5. *Achnatherum hymenoides* (Indian ricegrass).
© Maggie Gaddis

***Achnatherum hymenoides* (Indian ricegrass)** was an important species to indigenous people in the region. It is a species I've seen in very dry, inhospitable places, such as on the edge of dry slopes and falling off of trail sides. When the inflorescence first emerges from the rolled sheath, it is a tight ►

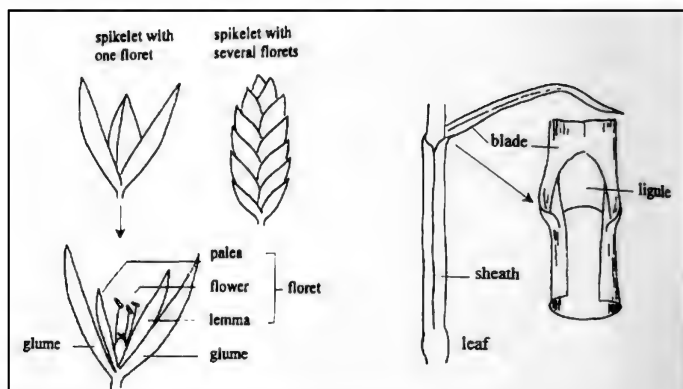


Figure 3. Basic vocabulary for grass identification.
© Wingate, J. 1986. A Simplified Guide to Common Colorado Grasses. Wingate Consulting, Denver, CO.

◀ bundle. When it is mature, it has an open panicle. At the end of each of those pedicels, you will find a round, black seed with many white hairs masking it. These are unique seed characteristics for grasses of the region. Notice that the blade is sloping gently from the node. There is a papery ligule inside of this junction between the sheath and the stem.



Figure 6. *Andropogon gerardii* (big bluestem).
© Maggie Gaddis

***Andropogon gerardii* (big bluestem)** is one of the tallest grasses you'll find. The inflorescence has three spikelets, which look like a turkey foot, a name the plant is affectionately called. Notice the many beautiful colors. The yellow petals hanging down are a reminder that grasses have flowers. There is a lot of red coloring as well, especially in autumn. The leaves have sparse and fine but long hairs sticking out of the leaves. The leaf pinches in and is lighter in color at the ligule.



Figure 7. *Aristida purpurea* (purple three-awn).
© Maggie Gaddis

***Aristida purpurea* (purple three-awn)** is a very low grass, prone to catching morning dew, which produces a sparkly and tangled haze above the grass. It is aptly named because there are three awns extending from each lemma. The awns are long and emphatically pointing in directions 60 degrees apart. There is no dramatic branching in the leaves as they emerge from the stem. I cannot identify this grass from the blades alone; instead, I look around for remnant inflorescences from seasons past to identify this grass.

***Bouteloua curtipendula* (sideoats grama)** is a delicate, mid-stature plant and an example of a raceme. The inflorescence is composed of many small spikes that hang to one side of the stem.

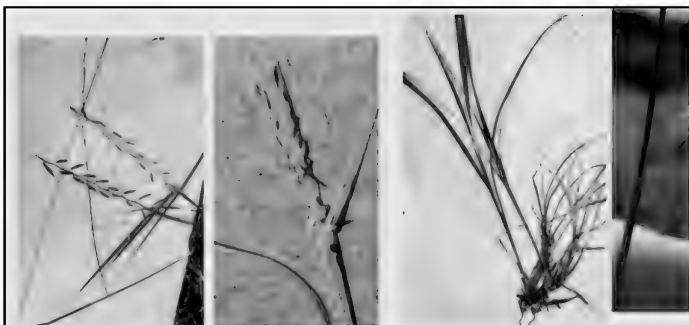


Figure 8. *Bouteloua curtipendula* (sideoats grama).
© Maggie Gaddis

There is no secondary branching. At the departure of the sheath from the stem at the ligule, there is angulation. The sheath is moderately hairy. The leaves are hairy and have a pronounced venation. The sparse hairs of *Bouteloua* spp. leaves remind me of the wisps of a teenager's beard. The stem gets even redder in autumn. This grass does not have a robust appearance, but its unique inflorescence is easy to identify.



Figure 9. *Bouteloua gracilis* (blue grama).
© Maggie Gaddis

***Bouteloua gracilis* (blue grama)** is Colorado's state grass. This mid-stature grass is codominant with *Buchloe dactyloides*. *B. gracilis* has a spike that is more than one centimeter long. It hangs to one side like a flag. The spike curls as it dries, giving the appearance of an eyelash—hence, its unofficial name: eyelash grass. There are profuse white hairs and a reddish color change at the node. The petals dangle from the spike as if they are not actually attached. *B. gracilis* senesces to a gray color and the leaves curl. ▶



Figure 10. *Buchloe dactyloides* (buffalograss).
© Maggie Gaddis

◀ ***Buchloe dactyloides* (buffalograss;** Figure 10) hides below the other grasses, performing an essential soil-stabilization service. Its stolons spread above ground, rooting down wherever soil contact allows. *B. dactyloides* can be grown as a drought-tolerant turf in domestic landscapes. The petals are a striking red, if you can get down on your hands and knees to see it. The leaves are covered in the pubescent hairs of the *Bouteloua* spp., a genus to which buffalograss once belonged. The leaves dry and curl.



Figure 11. *Bromus inermis* (smooth brome).
© Maggie Gaddis

***Bromus inermis* (smooth brome)** is a cool-season, pervasive, exotic range species. It was planted all over the American West during the Dust Bowl era as a forage grass. It is drought tolerant and a perennial with rhizomes. This makes it a fierce competitor to native grasses. The inflorescence is a robust, nodding panicle unlike any native species. The flowers are bright yellow. The leaves dry and curl to a purple-grey hue. I can tell smooth brome from far away in the fall because native grasses dry to a brighter yellow color, while *B. inermis* is a dull hue. The leaves have a distinctive marking, a crease in an M-shape; they also have obvious ribbing from the vertical venation. At the ligule, the sheath pinches in, while below the ligule the sheath rolls around the stem. Well-timed burning and high-intensity grazing can mitigate the coverage of this species.

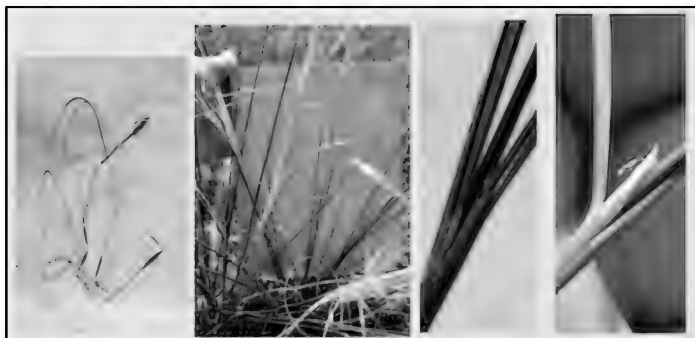


Figure 12. *Hesperostipa comata* (needle-and-thread grass). © Maggie Gaddis

***Hesperostipa comata* (needle-and-thread grass)** awns up to 23 centimeters long, which are twice as

long as those of *Aristida purpurea* (purple three-awn). As the name implies, the awn is so long, it appears to be a thread extending from a needle. When dry, the awn can appear twisted in addition to curled. The spikelets are arranged as a panicle terminating in one floret, which is the same arrangement as *A. purpurea* (purple three-awn). Despite their botanical similarities, these plants cannot be confused. *H. comata* is a medium-stature plant and much more erect in form. The ligule is white and papery.



Figure 13. *Nassella viridula* (green needlegrass).
© Maggie Gaddis

***Nassella viridula* (green needlegrass)** has a robust spikelet. It's heavy, unlike other native plants. There are so many florets really jam-packed on a spike. One of the most striking features of *N. viridula* is the rolled sheath, which is often dried. *N. viridula* has visible and stiff awns, but they are nowhere near as long as those of *H. comata*. I don't feel confident when identifying this plant in winter because the seeds are missing and so it looks wispy and vacant. The dried form can also be almost bleached in appearance, with only the glumes left on the spike. Nonetheless, the rolled sheath can always be verified, and no other grass has a similar erect and medium-height stature. A good search in the patch of suspected *N. viridula* will turn up some inflorescences with seeds still retained for confirmation.



Figure 14. *Schizachyrium scoparium* (little bluestem).
© Maggie Gaddis

***Schizachyrium scoparium* (little bluestem)** is my favorite grass! It is a delight to look at any day of the year. The hairy florets glisten in the early- or late-day rays of the sun. The inflorescence appears to be ►

◀ a spike, but it is a raceme with short pedicels. In autumn, the whole plant turns a reddish-purple color. Even in the growing season, the stems are red toward their bottoms. In comparison to *Bouteloua* spp., *S. scoparium* has wispy hairs emerging from the blades, which are flat or folded. The sheath is open. This mid-stature bunchgrass makes stately hedges along roadsides where the sheeting moisture facilitates its growth. For this reason, I do not consider *S. scoparium* to be the most drought-tolerant of native-grass species.



Figure 15. *Sporobolus cryptandrus* (sand dropseed).
© Maggie Gaddis

***Sporobolus cryptandrus* (sand dropseed)** is another grass with a panicle with one floret. Although it can be as delicate and inconspicuous as *A. purpurea*, it can grow taller, moisture permitting. *S. cryptandrus* has no awns and no wispy hairs on the leaves. At the ligule, there is a festive tuft of white hair, and the sheath makes a definitive angle. The nodes are reddish. The most striking feature of this grass is the contracted panicle early in the season. *A. hymenoides* also emerges in this fashion. The seeds of *S. cryptandrus* are minute in comparison to the seeds of *A. hymenoides*.

Maggie currently teaches biology, resource management, and conservation and sustainability courses at the University of Colorado, Colorado Springs. She is the CoNPS Southeast Chapter president, a restoration ecologist, and an ecological gardener. Maggie and Colorado Native Plant Society colleagues are working to develop a CoNPS citizen science program in which CoNPS members collect photo data using iNaturalist to support Budburst phenology research and other local research efforts. See iNaturalist working group meetings for more information: <https://conps.org/mfm-event-list/#/event-list> Starting September 1, she will be the first executive director of CoNPS.

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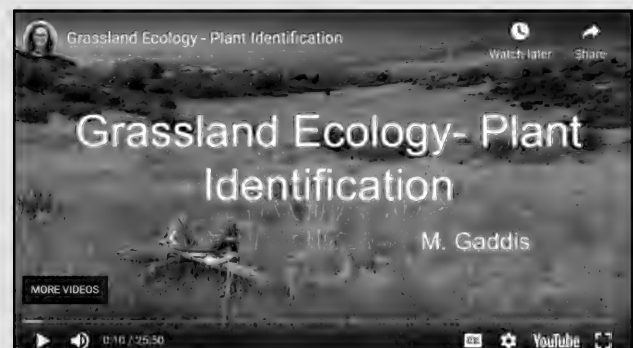
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To learn more about grasses, watch the two PowerPoint presentations Maggie has recorded.

One presentation is on grassland ecology in the Pikes Peak region.



The other presentation focuses on grass identification.



<https://conps.org/about-us/chapters/southeast-chapter/>

Featured Story

Colorado Native Plants for Phytoremediation: Improving Stormwater Quality with Plants in Urban and Suburban Landscapes

By Eric Fuselier

Native plants have been getting a lot of well-deserved attention in recent years. As the public has become increasingly aware of troubling population declines in pollinator and wildlife species, due in part to habitat loss, we are starting to see native plants used more and more in gardening and landscaping practices.

This is, of course, great news and encouraging to see. But for all the buzz around native plants, there is another benefit many of these species can provide that I believe has been thus far mostly overlooked.

Phytotechnology and Phytoremediation

Phytotechnology is an emerging field that uses the existing properties of plants in order to accomplish defined outcomes in a designed environment. One such application of phytotechnology is contaminant removal, otherwise known as phytoremediation. The benefits of using this approach include providing wildlife habitat while being more sustainable, costing less, and providing better aesthetics than traditional methods of environmental remediation.

Phytoremediation makes use of the natural ability of certain plant species to accumulate, sequester, or breakdown contaminants found in the environment. Much research has been devoted to testing the suitability of certain plant species for remediating specific contaminants, with many of these species being native to one region or another of the US. This approach to environmental remediation is more often applied on large scales (for instance, for the remediation of contaminated soil at brownfield sites). However, the concepts and body of knowledge regarding phytoremediation using native species can also be applied on much smaller scales to the mutual benefit of both the ecosystem and society.

In this article, we will focus on the use of phytotechnology to address a serious problem most municipalities and land managers face: polluted stormwater. Because impervious surfaces such as roads, parking lots, and buildings occupy a significant portion of the urban and suburban landscape, they prevent the soil from absorbing stormwater. Instead, most of this stormwater flows laterally across these surfaces, transporting any contaminants it picks up along the way into the nearest storm drain. From there, the contaminated water flows directly into a local stream or other waterbody. Any contaminants that do not make it into the body of water typically are absorbed by soil near the contaminant's source.



Bioswale accepting stormwater runoff at Mitchusson Park low-impact-development parking lot. © Eric Fuselier

Let's consider how we can implement phytotechnology using native plant species to improve stormwater runoff before it enters these habitats, as well as some of the common contaminants that may affect the health of soil and aquatic habitats.

How it Works

There are five main phytotechnological mechanisms that we can apply when trying to improve stormwater quality:

Phytodegradation uses certain plant species to take up the contaminants through their roots and break them down internally through the plant metabolic processes. Through phytodegradation, contaminants are degraded, incorporated into the plant tissues, and used by the plants as nutrients. Fast-growing species may take up and store contaminants faster and in larger amounts than species with more average growth rates. Nitrogen-fixing pioneer species are also currently being studied due to their fast growth rates, high biomass, and hardiness.

Phytostimulation is the process by which contaminants are broken down in the soil by microbial activity that ►

◀ is enhanced by the compounds exuded from the roots of a plant. Many of the microorganisms in soil, such as yeast, fungi, and bacteria, can utilize harmful organic substances as their nutrient sources, and in the process degrade them into harmless substances. Natural exudates from plant roots, such as sugars, alcohols, and carbon-containing acids, provide food for these soil microorganisms and enhance their metabolic activity. In addition, the loosening of soil by plant roots and water availability in the root zone also aid the phytostimulation process. While it is a slower process than phytodegradation, phytostimulation is very effective.

Phytoextraction refers to the absorption and uptake by plants of large amounts of inorganic contaminants such as heavy metals and nutrients from the environment, and to the translocation of these contaminants into the aboveground parts of these plants. With this technique, consider using woody species that produce high biomass and are classified as hyper-accumulators of these contaminants. If hyper-accumulator species are not available or not ideal to use at a site, then species known to accumulate a targeted contaminant in lesser quantities, but that still produce high biomass, can also be effective for phytoextraction.

Phytostabilization is the use of certain plant species to immobilize contaminants found in soil and groundwater through various mechanisms, including absorption and accumulation of the contaminant by the roots of these plants, adsorption of the contaminant onto the surface of the plants' roots, or through the precipitation of the contaminant within the root zone of the plants. This latter mechanism makes use of certain chemicals exuded by the roots of these species to immobilize or precipitate the targeted contaminant. Moreover, the transport proteins associated with the root zones of certain species are able to irreversibly bind and stabilize some contaminants. Alternatively, these contaminants can be taken up by the roots and become sequestered by the root system. It should be noted that this technique does not remove the contaminants from the site, but effectively immobilizes or stabilizes them, making them unavailable for entry into the food chain.

Phytohdraulics refers to the ability of certain plant species to capture, transport, and transpire water from the environment. With this technique, plants can be used to draw contaminated groundwater toward their roots in order to change the speed or direction of groundwater flow, or to modify groundwater levels at a

site. Species with high evapotranspiration rates are best for this purpose; however, such species are often not drought tolerant, so irrigation may be needed, depending on site conditions. It is important to note that this mechanism does not degrade the targeted contaminants, but can be combined with other mechanisms such as phytodegradation or phytostimulation to serve this purpose.



Indiangrass (*Sorghastrum nutans*). © Eric Fuselier

Phytoremediation is best suited for sites with low to moderate levels of contamination, where the level of toxicity is not high enough to inhibit plant growth. Potential applications of these phytotechnological mechanisms to improve stormwater quality include their use in rain gardens, bioswales, detention ponds, and other stormwater control structures strategically located to accept runoff from parking lots, roadways, dry cleaners, autobody shops, industrial and manufacturing sites, and other sites where contaminants commonly occur in the runoff. Specific contaminants are discussed below, along with the native plant species that can be used to

remediate or control them using the phytotechnological mechanisms discussed above.

Sediment and Turbidity

Turbidity, which is the measure of the amount of suspended sediment in water, can negatively impact aquatic ecosystems by restricting the depth that sunlight is able to reach. Without sunlight, algae in the water are unable to perform photosynthesis, a process that provides aquatic organisms, such as fish and macroinvertebrates, with the dissolved oxygen that they need in order to breathe. High turbidity levels can also lead to soil particles becoming lodged in fish gills, restricting the fish's ability to breathe, causing them to suffocate.

A common source of sediment causing high turbidity levels in our waterways is erosion originating from construction sites, agricultural fields, logging activities, and eroding streambanks. Phytotechnology can be an effective way to remove this sediment from stormwater before it enters the local waterways.

To effectively contain sediment on-site, we can select fast-growing species that produce dense foliage and high quantities of biomass. The density of the foliage and high biomass help to slow down and filter stormwater as it enters a body of water, facilitating the deposition of any sediment it may contain. Table 1 contains a list of native plant species that meet these criteria and can be combined with other Best ►

Table 1: Plants That Retain Sediment

Scientific Name	Common Name
<i>Andropogon gerardii</i>	Big bluestem
<i>Bouteloua curtipendula</i>	Side oats grass
<i>Bouteloua gracilis</i>	Blue grama
<i>Elymus canadensis</i>	Canada wild rye
<i>Panicum virgatum</i>	Switchgrass
<i>Schizachyrium scoparium</i>	Little bluestem
<i>Sorghastrum nutans</i>	Indiangrass

◀ Management Practices for erosion control to contain sediment on-site more effectively.

Including these species within riparian buffers (vegetated areas along the banks of streams, lakes, and other waterbodies), and downslope or adjacent to construction sites and logging activities, is an additional measure companies can take to reduce turbidity levels in local waterways and prevent the adverse impacts that turbid stormwater runoff can have on sensitive aquatic ecosystems.

Nutrient Pollution

While nutrients are necessary to support the organisms that live in aquatic habitats, excessive levels of nutrients lead to eutrophication, a process that creates harmful algal blooms that can result in fish kills and other damage to aquatic ecosystems. Common sources of excess nutrients in our local waters include fertilizers applied to lawns, fields, and agricultural lands; dead or freshly cut vegetation entering streams and waterbodies; and even sediment originating from sources listed in the previous section of this article.

Table 2: Phreatophytes Native to Colorado

Scientific Name	Common Name
<i>Acer negundo</i>	Box elder
<i>Atriplex canescens</i>	Four-wing saltbush, chamiso
<i>Celtis reticulata</i>	Netleaf hackberry
<i>Populus angustifolia</i>	Narrowleaf cottonwood
<i>Populus balsamifera</i>	Balsam poplar
<i>Populus tremuloides</i>	Quaking aspen
<i>Purshia stansburyana</i>	Stansbury's cliffrose
<i>Salix amygdaloides</i>	Peachleaf willow
<i>Salix drummondiana</i>	Drummond's willow
<i>Salix brachycarpa</i>	Short fruit willow
<i>Salix exigua</i>	Coyote willow
<i>Salix lasiandra</i>	Shining willow
<i>Salix bebbiana</i>	Pussy willow
<i>Salix ligulifolia</i>	Strapleaf willow
<i>Salix planifolia</i>	Planeleaf willow
<i>Salix scouleriana</i>	Scouler's willow
<i>Sambucus nigra</i>	Black elderberry
<i>Sambucus racemosa</i>	Red elderberry
<i>Sarcobatus vermiculatus</i>	Black greasewood

Woody species with high growth rates are excellent for reducing the amount of nutrient pollution that enters waterways. Phreatophytes, which are deep-rooted trees and shrubs that obtain a significant portion of the water they need from the water table, meet these criteria and can be very useful for this purpose. Often found growing in arid locations or in areas with standing or running water, phreatophytes typically have fast growth rates, and can thus take up a lot of nutrients in a short amount of time as they incorporate these nutrients into their biomass. Utilizing these special qualities for both phytohydraulics and phytoextraction can help remove nutrients from stormwater before they enter local waterways. See Table 2 for a list of phreatophytes native to Colorado.

Herbaceous species that have high growth rates and produce high biomass can also be effective at reducing the amount of nutrients entering our waterways. Table 3 is a list of native herbaceous species that possess these qualities. Including these species and/or phreatophytes in stormwater detention structures, such as rain gardens, bioswales, and detention basins, will give these species additional time to take up nutrients and prevent nutrients from entering local bodies of water.

Table 3: Plants That Reduce Nutrient Pollution

Scientific Name	Common Name
<i>Andropogon gerardii</i>	Big bluestem
<i>Panicum virgatum</i>	Switchgrass
<i>Schizachyrium scoparium</i>	Little bluestem
<i>Sorghastrum nutans</i>	Indiangrass
<i>Spartina pectinata</i>	Prairie cordgrass
<i>Vicia americana</i>	American vetch

The species listed in Tables 2 and 3 can also be planted at other types of sites to reduce the amount of nutrients that are entering aquatic ecosystems and to prevent eutrophication of downstream waterbodies. These locations include riparian buffers along the banks of streams and rivers, the edges of lakes and ponds, and in vegetative filter strips, constructed wetlands, and other stormwater-control infrastructure receiving runoff from sources containing excess nutrients.

Petroleum

Most petroleum products have a density less than that of water, and thus tend to float and spread into a thin layer on the water surface (called a sheen). However, once in the water they can be harmful to wildlife and have adverse impacts on aquatic ecosystems.

Sources of petroleum in stormwater can include fuel spills from engine maintenance and repair activities, petroleum extraction activities, and leaks from above- and underground storage tanks. Other sources are ▶

◀ engines dripping motor oil, grease, gasoline, and diesel onto the surfaces of parking lots, driveways, roadways, and railyards.

Some categories of petroleum are easy to degrade. These include gasoline and diesel fuel; methyl tert-butyl ether; benzene, toluene, ethylbenzene, and xylene; and other aliphatic hydrocarbons. Phytotechnological mechanisms useful for remediating these categories of petroleum include phytostimulation and phytodegradation.

Other categories of petroleum, such as polycyclic aromatic hydrocarbons, coal tar, crude oil, and heating oil are much more difficult to degrade. Because of this, phytostimulation is the only useful phytotechnological mechanism for remediating soil and water contaminated with these categories of petroleum.

Table 4 is a list of species shown through research to have the ability to remediate soil contaminated with certain petroleum categories. Including these species in rain gardens, bioswales, vegetative filter strips, riparian buffers, and constructed wetlands in locations

receiving stormwater that may contain petroleum could help reduce the damage to aquatic ecosystems.

Pesticides

Pesticides can enter aquatic ecosystems through stormwater runoff from lawns, fields, agricultural lands, roadsides, rail corridors, and utility corridors. Once in the aquatic environment, pesticides can cause direct harm to fish and aquatic invertebrates, as well as reduce the availability of aquatic plants and insects that serve as habitat or food for fish and other aquatic organisms.

Table 5 is a list of species that have been shown through research to have the ability to remediate soil and water contaminated with specific pesticides through various phytotechnological mechanisms, such as phytodegradation, phytoextraction, phytostimulation, and phytostabilization.

Useful locations for these species include rain gardens, bioswales, vegetative filter strips, and constructed wetlands, as well as edges of streams, rivers, lakes, and other waterbodies that receive stormwater runoff from parks, orchards, fields, ►

Table 4: Plants Effective at Reducing Petroleum Pollutants

Scientific Name	Common Name	Targeted Contaminant *
<i>Andropogon gerardii</i>	Big bluestem	PAH
<i>Bouteloua curtipendula</i>	Side oats grass	TPH, PAH
<i>Bouteloua dactyloides</i>	Buffalograss	TPH, PAH
<i>Bouteloua gracilis</i>	Blue grama	PAH
<i>Elymus canadensis</i>	Canada wild rye	TPH, PAH
<i>Juniperus virginiana</i>	Eastern red cedar	BTEX
<i>Panicum virgatum</i>	Switchgrass	Anthracene, PAH (total priority), Pyrene, TPH
<i>Populus angustifolia</i>	Narrowleaf cottonwood	Aniline, Benzene, Ethylbenzene, Phenol, Toluene, m-Xylene, PAH, BTEX, MTBE, DRO, TPH
<i>Populus balsamifera</i>	Balsam poplar	Aniline, Benzene, Ethylbenzene, Phenol, Toluene, m-Xylene, PAH, BTEX, MTBE, DRO, TPH
<i>Populus deltoides</i>	Eastern cottonwood	Aniline, Phenol, m-Xylene, PAH, BTEX, MTBE, DRO, TPH
<i>Populus tremuloides</i>	Quaking aspen	Aniline, Benzene, Ethylbenzene, Phenol, Toluene, m-Xylene, PAH, BTEX, MTBE, DRO, TPH
<i>Salix amygdaloides</i>	Peachleaf willow	DRO, TPH, BTEX, PAH
<i>Salix drummondiana</i>	Drummond's willow	DRO, TPH, BTEX, PAH
<i>Salix brachycarpa</i>	Short fruit willow	DRO, TPH, BTEX, PAH
<i>Salix exigua</i>	Coyote willow	DRO, TPH, BTEX, PAH
<i>Salix lasiandra</i>	Shining willow	DRO, TPH, BTEX, PAH
<i>Salix bebbiana</i>	Pussy willow	DRO, TPH, BTEX, PAH
<i>Salix ligulifolia</i>	Strapleaf willow	DRO, TPH, BTEX, PAH
<i>Salix planifolia</i>	Planeleaf willow	DRO, TPH, BTEX, PAH
<i>Salix scouleriana</i>	Scouler's willow	DRO, TPH, BTEX, PAH
<i>Schizachyrium scoparium</i>	Little bluestem	PAH
<i>Sorghastrum nutans</i>	Indiangrass	TPH, PAH
<i>Spartina pectinata</i>	Prairie cordgrass	PAH
<i>Typha latifolia</i>	Broadleaf cattail	DRO, Oil and gasoline, Phenol, TSS, BOD, COD

*Acronyms: BOD, biological oxygen demand; BTEX, benzene, toluene, ethylbenzene and xylene; COD, chemical oxygen demand; DRO, diesel range organics; MOH, mineral-oil hydrocarbons; MTBE, methyl tert-butyl ether; PAH, polycyclic aromatic hydrocarbon; TBA, tert-butyl alcohol; TPH, total petroleum hydrocarbon; TSS, total suspended solids.

Table 5: Plants Effective in Pesticide Remediation

Scientific Name	Common Name	Contaminant Targeted*
<i>Andropogon gerardii</i>	Big bluestem	Chlorpyrifos, Chlorothalonil, Pendimethalin, Atrazine, Propiconazole
<i>Juniperus virginiana</i>	Eastern red cedar	Alachlor, Atrazine, Metolachlor, Chlorpyrifos
<i>Panicum virgatum</i>	Switchgrass	Pendimethalin, Atrazine
<i>Pinus ponderosa</i>	Ponderosa pine	Atrazine
<i>Populus angustifolia</i>	Narrowleaf cottonwood	Alachlor, Atrazine, Metolachlor, Chlorpyrifos
<i>Populus balsamifera</i>	Balsam poplar	Alachlor, Atrazine, Metolachlor, Chlorpyrifos
<i>Populus deltoides</i>	Eastern cottonwood	Alachlor, Atrazine, Metolachlor, Chlorpyrifos
<i>Populus tremuloides</i>	Quaking aspen	Alachlor, Atrazine, Metolachlor, Chlorpyrifos
<i>Salix amygdaloides</i>	Peachleaf willow	Chlorpyrifos
<i>Salix drummondiana</i>	Drummond's willow	Chlorpyrifos
<i>Salix brachycarpa</i>	Short fruit willow	Chlorpyrifos
<i>Salix exigua</i>	Coyote willow	Chlorpyrifos
<i>Salix lasiandra</i>	Shining willow	Chlorpyrifos
<i>Salix bebbiana</i>	Pussy willow	Chlorpyrifos
<i>Salix ligulifolia</i>	Strapleaf willow	Chlorpyrifos
<i>Salix planifolia</i>	Planeleaf willow	Chlorpyrifos
<i>Salix scouleriana</i>	Scouler's willow	Chlorpyrifos
<i>Sorghastrum nutans</i>	Indiangrass	Pendimethalin, Atrazine
<i>Spartina pectinata</i>	Prairie cordgrass	Alachlor, Atrazine, Metolachlor, Chlorpyrifos
<i>Typha latifolia</i>	Broadleaf cattail	Alachlor, Atrazine, Metolachlor, Chlorpyrifos

◀ transportation and utility corridors, and residential areas where these pesticides are being used.

Conclusion

The lists of species and contaminants covered in this article are by no means exhaustive. Other potential contaminants that could be targeted using phytotechnology include chlorinated solvents originating from current or historical dry-cleaning operations; air pollutants originating from roadways, interstates, and airports; and heavy metals originating from agricultural activities, industrial sites, and mining and smelting operations. By utilizing the growing body of research available regarding phytotechnology using native plant species, these species can be strategically selected and placed on the landscape to either degrade or extract a variety of contaminants found in the soil, water, and air.

It is my belief that native plants are currently not being utilized to their fullest potential when selected for native gardens or landscapes. So I encourage anyone with an interest in landscaping, native plant gardening, or the health of aquatic environments to consider how surrounding land uses may impact environment by contaminating stormwater. With the help of native plants, pollutants and contaminants can be removed or degraded, and environmental quality improved.

In time, my hope is that native-plant gardeners and landscapers, as well as professionals responsible for managing stormwater, will become just as knowledgeable about the native plant species that are useful for remediating specific contaminants as they are about

the species that are beneficial for specific pollinators. By applying these additional functions of native plant species to the landscape in a thoughtful manner, we can work not only to improve the plight of pollinators, but also to improve the environment as a whole.

Eric Fuselier is an Environmental Project Manager at Crafton Tull where he works with civil engineers and landscape architects to incorporate phytotechnology using native plant species for the rain gardens, bioswales, detention ponds, and commercial development projects they design. Eric also serves as a national director for Wild Ones – Native Plants, Natural Landscapes, and as the president of the Arkansas Native Plant Society.

Editor's Note: Readers may wonder if using native plants for phytoremediation creates risk to birds, insects, and other animals that rely on those species for food, pollen, nectar, or other uses. Author Eric Fuselier addressed that question for us: "I would be concerned with herbivores eating the plants from phytoremediation sites where contamination levels are high (e.g., from toxic spills, Superfund sites, Brownfield sites, etc.). Sometimes a fence is placed around these phytoremediation projects to prevent this from occurring. But as far as remediating or improving stormwater, I don't think that this is much of a concern since the contaminant levels are much, much lower. Many of the organic contaminants are broken down into non-toxic substances as the plants metabolize them. However, I would like to see more research on whether species that are hyperaccumulators of heavy metals have any impact on insects (do these heavy metals make it into the pollen? I don't know) when heavy metal concentrations in the soil or water are at toxic levels. But for the purposes of this article, we're speaking about low levels of contamination that I don't think would be a concern for herbivores or insects using the plants in rain gardens, bioswales, etc." GH

"Phytoremediation..." continued on page 32 ►

Research and Reports

Can Shrubs Act as Stepping-Stones for Subalpine Vegetation to Move Uphill?

By Laurel Brigham

Across the alpine, an important phenomenon is occurring: mountaintops covered in low-lying vegetation are becoming dotted with shrubs (Myers-Smith et al., 2011; Formica et al., 2014; Bueno de Mesquita et al., 2018). These shrubs are taller and wider than the existing vegetation, thereby accumulating snow, offering shade, and providing protection from wind. These types of small-scale alterations to climate (microclimates) are not only created by shrubs but are also promoted by other aspects of the incredible topographic heterogeneity of the alpine—windswept ridges and snow-filled depressions are also microclimates.

Microclimates interact with snow, wind, and solar radiation to drive water and energy balances across the landscape and have been shown to be important to a species response to climate change (Harrison et al., 2010; Scherrer and Körner, 2011; Whitbeck et al., 2016; Devaney et al., 2017). As shrubs continue to move uphill, they might promote favorable microclimates for other species to use as stepping-stones, allowing them to move into the alpine even though the overarching climate would otherwise be uninhabitable for them.

On the other hand, migrating species could be prevented from establishing as a result of competitive interactions with other plants that are already established in the alpine (Hille Ris Lambers et al., 2013; Alexander et al., 2015). This would indicate priority effects, with the order of arrival determining community membership. Consequently, the influence

of microclimates and plant-plant interactions on species ranges may be important for making predictions of habitat suitability and population persistence in the face of global warming.

This study examines how the microclimates created by shrubs, which are moving upward in elevation at a rapid pace (Formica et al., 2014), may interact with the resident alpine community to influence subalpine forb establishment in the alpine. I hypothesize that the shrub microclimate will enhance subalpine forb germination, but that neighboring alpine species may hinder germination regardless of shrub presence.

This research was conducted in a moist meadow at Niwot Ridge on the Front Range of Colorado (3,480 meters above sea level). In the summer of 2019, more than 6,000 seeds from four subalpine and one alpine species were planted (Figure 1) on the leeward side of shrubs and in open tundra. Subalpine and alpine species responses were chosen for comparison to determine whether there is a species-specific effect of the benefits of the shrub microclimate on germination rates and seedling establishment. However, germination in 2019 was only high enough for analysis of *Erigeron glacialis* and *Deschampsia cespitosa*. We also removed neighboring species from half of the plots to determine whether neighbors would impact establishment.

Plots were monitored for germination in 2019 and again in 2020 to determine overwinter survival (Figure 2). After observing germination, along with soil temperature and soil moisture, in 2019, we determined that it was necessary to collect additional

data in 2020 in order to fully understand the patterns being detected. Therefore, in the summer of 2020, I also collected information on the amount of solar radiation reaching each of the plots, and I collected soil to measure soil pH and soil organic matter. ►

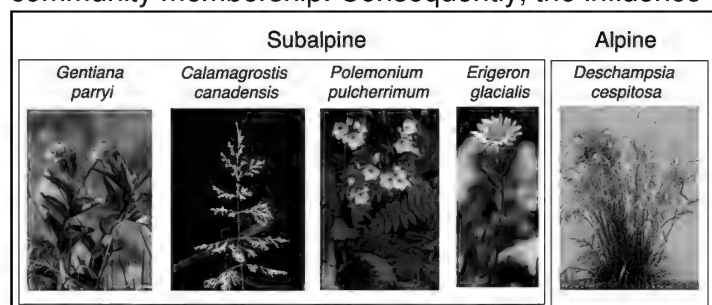


Figure 1. The subalpine and alpine species seeded in the experiment. © Jane Smith (*Gentiana parryi*, Parry's gentian; *Polemonium pulcherrimum*, Jacob's ladder; and *Erigeron glacialis*, subalpine daisy) and Peter M. Dziuk (*Deschampsia cespitosa*, tufted hairgrass; and *Calamagrostis canadensis*, bluejoint grass).



Figure 2. An *Erigeron glacialis* seedling. © Laurel

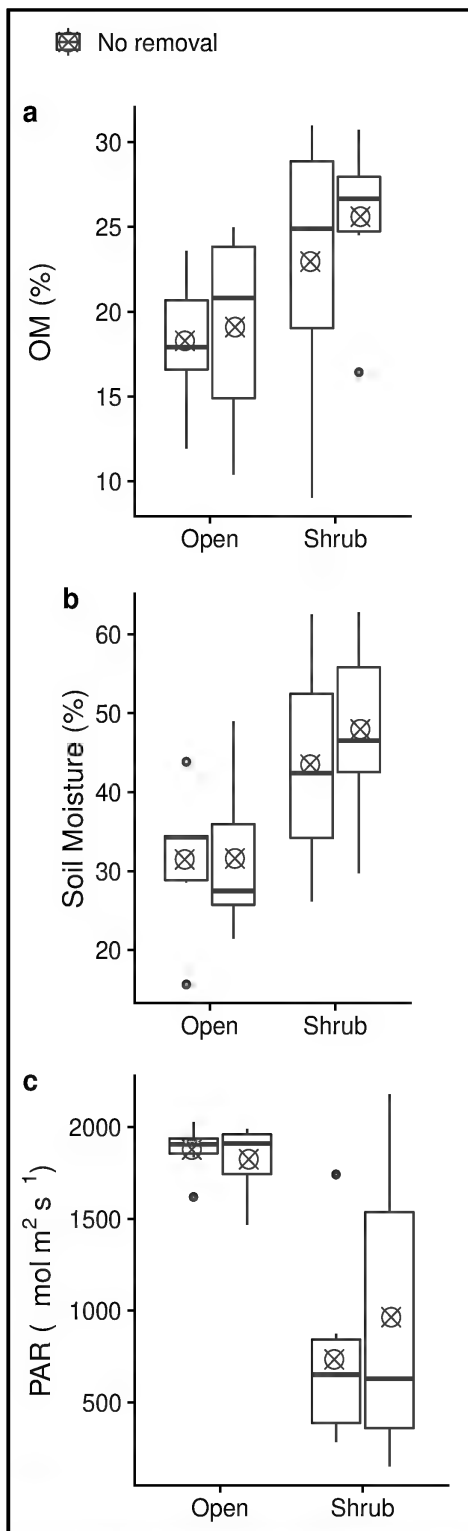


Figure 3. The soil (a and b) and light (c) environment varied between open tundra and the leeward side of shrubs, such that shrubs had higher OM and soil moisture, and lower PAR levels.

◀ In terms of the abiotic effects of shrubs, we found that shrubs did not alter soil pH, but their presence did increase soil organic matter, correspond with higher soil

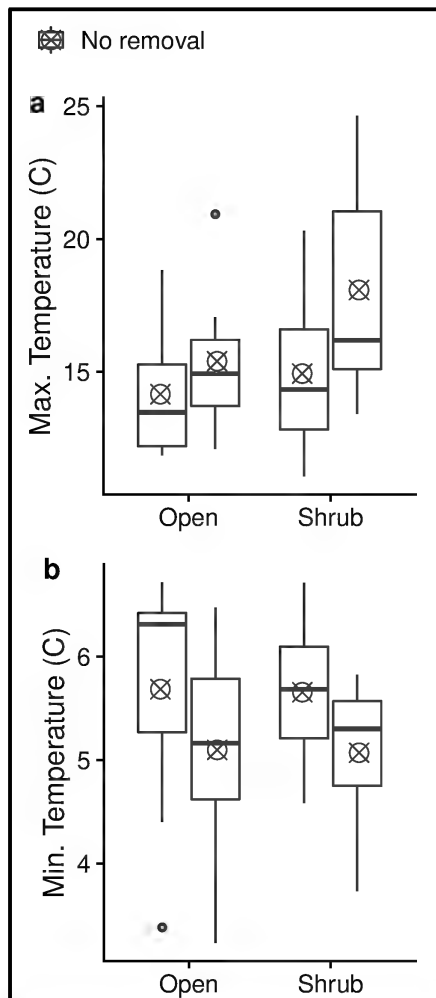


Figure 4. The removal of neighboring alpine plants (a) increased maximum temperatures and (b) decreased minimum temperatures, demonstrating the temperature buffering capacity of the resident alpine plant community.

moisture at peak biomass, and decrease the amount of incoming solar radiation (Figure 3). This confirmed the presence of shrub microclimates at our site. In addition to the shrub microclimate, we also detected a microclimate created by the resident alpine vegetation. Our removal treatment increased maximum and decreased minimum soil temperatures (Figure 4).

Thirteen and 16 out of the 28 plots demonstrated germination of *E. glacialis* and *D. cespitosa*, respectively. The likelihood of *E. glacialis* germination was not shaped by shrub presence or

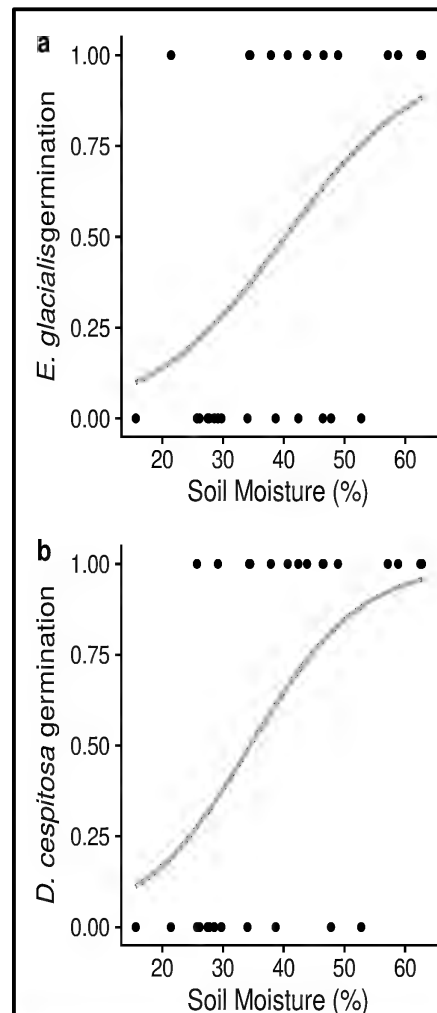
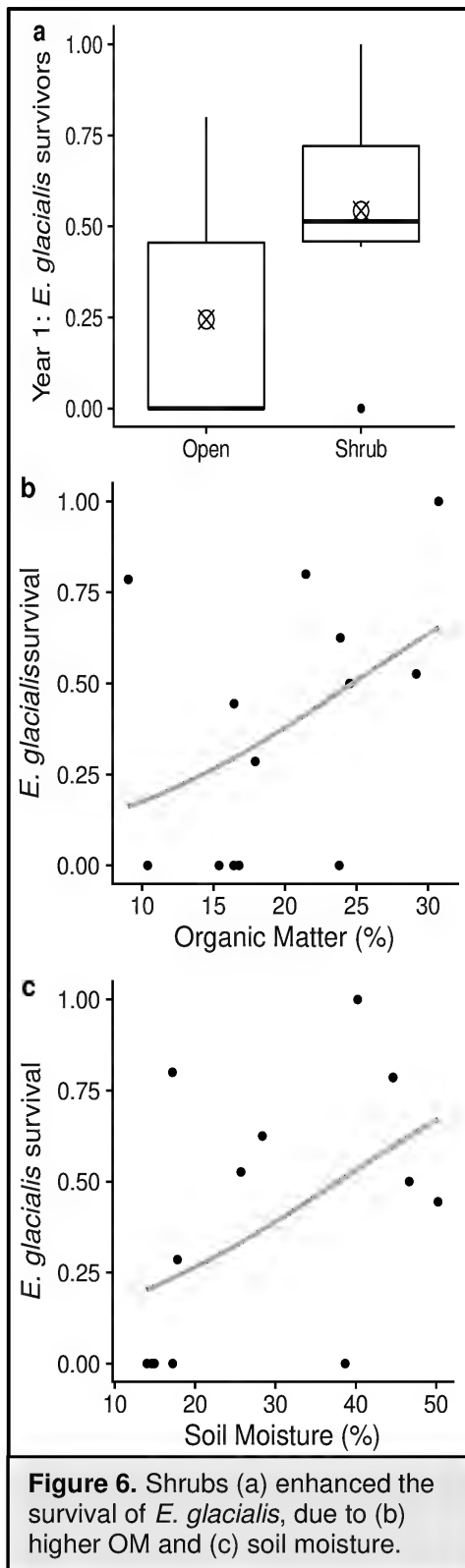


Figure 5. Soil moisture had a positive effect on the likelihood of germination for both (a) *E. glacialis* and (b) *D. cespitosa*.

neighbors, only by a natural gradient in soil moisture where higher soil moisture enhanced germination (Figure 5a). The likelihood of *D. cespitosa* germination was also positively related to soil moisture (Figure 5b). About 40 percent and 50 percent of *E. glacialis* and *D. cespitosa* germinants, respectively, survived the growing season. The proportion of *E. glacialis* survivors was increased by shrub presence, driven by the positive effects of shrubs on soil moisture and organic matter (Figure 6). *Deschampsia cespitosa* survival was increased by lower minimum temperatures (Figure 7). These results suggest ▶



◀ that our subalpine species may be able to germinate in the alpine regardless of shrub presence, but that the first-year survival of our subalpine species could be increased by shrubs.

In the second year, the survival of seedlings was no longer influenced

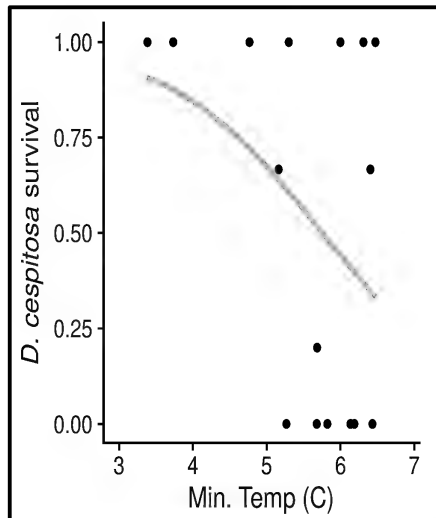


Figure 7. Minimum temperatures had a negative effect on the survival of *D. cespitosa*.

by shrubs. Instead, *E. glacialis* experienced higher survival in plots where neighbors had been removed (Figure 8). This suggests that competition from alpine neighbors may hinder long-term establishment of subalpine plants. On the other hand, no treatment variables explained the second-year survival of *D. cespitosa*, suggesting a role for stochasticity.

The comparison between the subalpine and alpine species elucidated the following: the likelihood of germination for both species was shaped by soil moisture, only the subalpine species experienced a positive effect of the shrub microclimate on first-year survival, and only the subalpine species experienced a negative impact of alpine neighbors on second-year survival. Therefore, while shrubs provided benefits for the subalpine species during the first year, suggesting their role as a stepping-stone, these effects are diminished by competition from nearby alpine plants later in the life of the seedling.

From a conservation perspective, these findings suggest that shrubs could be a useful stepping-stone for

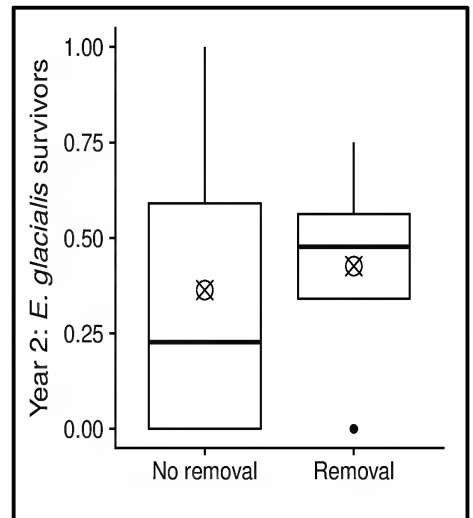


Figure 8. In the second year, only the neighboring plant community shaped the survival of *E. glacialis* such that survival was lower when neighbors were not removed.

natural migration or a site for assisted migration, but that the neighboring plant community would need to be managed in tandem. As climate change influences the uphill migration of subalpine species in order to persist, microclimates may be an important component to understanding their survival.

I am thankful to the Colorado Native Plant Society for their funding via the John W. Marr grant during the 2020 field season, which made possible the collection of important environmental data relating to the microclimate effects of shrubs. I am also thankful for the two undergraduates who helped me plant those thousands of seeds in 2019, Micaela Seaver and Cate Porter. Finally, I am thankful for the Niwot Ridge Long Term Ecological Research Program station and staff.

Laurel Brigham is a PhD candidate in the Ecology and Evolutionary Biology Department at the University of Colorado, Boulder. She is conducting her dissertation research in the alpine at the Niwot Ridge Long Term Ecological Research Program station. Broadly, she is interested in how landscape-level heterogeneity, driven by microhabitats, influences plant persistence under global change. 🌀

Research and Reports

A New-for-Colorado Bryophyte Species

by Stacey Anderson

Plagiobryoides renauldii, an acrocarpous moss not previously known from Colorado, was found at Unaweep Seep State Natural Area in Mesa County. A bryophyte survey of the natural area was conducted on April 11, 2021, by a group of bryologists, including myself, Paula Lehr, and Ron Wittmann from Colorado, along with Karen Blisard and Russ Kleinman from New Mexico. Russ Kleinman identified the moss found on wet soil along the east bank of West Creek at an elevation of 5,800 feet. It was confirmed by John R. Spence, the current authority for the family Bryaceae in *Flora of North America*.

Unaweep Seep Natural Area is known for wetland types created by the many seeps occurring in the 145-acre area that support a diversity of plant and wildlife species. The Audubon Society has recognized it as an Important Bird Area for the extensive bird populations found there. This was the first moss survey done in the area.

Plagiobryoides renauldii (http://dev.semanticfna.org/Plagiobryoides_renauldii) is a member of the Bryaceae family of mosses and, until now, has only been known from New Mexico and Arizona in the United States and Canada. It is a robust aquatic species, with stems one to three centimeters long, dark to golden green with a blunt leaf apex and a costa not quite reaching the tip. You can find some wonderful photographs of the species by Russ Kleinman and Karen Blisard at https://wnmu.edu/academic/nspages/gilaflora/plagiobryoides_renauldii.html

The eclectic group of bryologists (including Mo Ewing and Kelly Allred, not present) are working together to increase understanding about the occurrence and distribution of mosses and liverworts in Colorado and New Mexico. Three other Colorado Natural Areas— Escalante Canyon, Rough Canyon, and Fruita Paleontological Locality— were also surveyed by members of the group. All work was done through a Bureau of Land Management permit for collection of bryophytes, with the help of Anna Lincoln at the BLM and Savannah Smith at the CNAP.

Plagiobryoides renauldii (Röll ex Renauld & Cardot) JR Spence: Stacey Anderson collection 210412-14, Mesa County, 9 miles northeast of Gateway, CO along state Hwy 141 in Unaweep Seep Natural Area; Quad: Two V Basin; WGS 84: 38 ° 46' 24" N 108 ° 53' 5" W. Elevation 5760 ft. East bank of West Creek on rock. Determined by Russ Kleinman; confirmed by John R. Spence

The specimen will be deposited in the COLO Herbarium at the Museum of Natural History on the University of Colorado Boulder campus

(<https://www.colorado.edu/cumuseum/research-collections/botany-section-university-herbarium-colo>). 



Plagiobryoides renauldii samples. A. Sample collected for the herbarium. B. Stem detail. C. Leaf micrograph. © Stacey Anderson

Candelabra Cactus (*Cylindropuntia imbricata*)

By Jim Borland

Thorns, bristles, spines, or “jaggers,” as we called them as kids, are not especially popular on landscape plants, even in lands where the natural landscape is covered with plants that sport such “pokeys.” Nevertheless, these plants not only serve an important ecological role, but also occupy vast portions of the southwestern United States.

Candelabra cactus is one of 22 species in the genus *Cylindropuntia*, so-named because of their round-stemmed branches. They are also known as chollas or cane cacti, several of which are noted for their ability to “jump” onto and hold tenaciously to anyone passing nearby. Because this cactus—with its tough, hooked, red, pink, or brown one- to one-and-a-half-inch-long spines—lacks such leaping and holding ability, penitentes bound its branches to their backs during Holy Week as an act of contrition.

Growing north into the Arkansas River drainage in Colorado from as far south as Guanajuato, Mexico, only one other *Cylindropuntia* is found farther north (*Grusonia pulchella*). Here and farther north where it has been

planted, *C. imbricata* is hardy to at least -15°F (USDA Zone 5b) and subjected to 15–30 inches of mean annual precipitation. Curiously, about 50 percent of the variation in the moisture content of its branches can be accounted for by variations in the percentage of soil moisture found at the two-inch depth level of soil. Branch growth, however, is correlated with the time of year when soil moisture content is at its lowest. It prefers dry soil but tolerates a variety of well-drained soils, from gravelly to clayey.

Associates in the grasslands, hills, arroyos, and flats to deep canyons where it dwells include blue grama, side oats grama, hairy grama, sand dropseed, ring muhly, and mat muhly, along with pinyon pine, one-seed juniper, and wavy-leaf oak. Here, it branches extensively in a whorled pattern up to 15 feet tall and

wide, with new branches succulent and old branches becoming lignified with age. A giant form sometimes called *C. imbricata* var. *vexans* is a rapid grower with annual stem growth to as much as twice that of normal. When plants die, hollow cylindrical cores remain, consisting of diamond-shaped holes surrounded by a woody network. These woody cores are used for curios, picture frames, lamps, furniture, and walking sticks, thus the reason for another of its common names: walking-stick cholla.



Cholla (*Cylindropuntia imbricata*) blossom with pollinator. © Sue Keefer

Depending upon latitude, blooming begins as early as May or as late as July with three- to four-inch-wide rose-pink blossoms arising from the terminal portion of old branches. They remain blooming for two or more weeks. White-, purple-, apricot-, plum-, red-, and green-flowered forms are known and available in the trade. The one- to one-and-a-half-inch-long globose fruit, containing many seeds, is at first yellow, becoming dry with deciduous spines. The one-tenth-inch-long yellowish-gray to tan seeds are germinated, according to Norman C. Deno, *Seed Germination Theory and Practice, First Supplement to*

the second edition, at 70°F in the dark, where 40 percent germination can be expected in the third week.

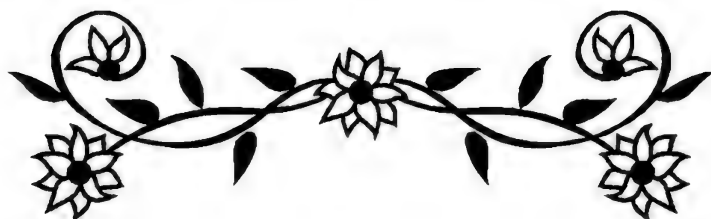
Cuttings of practically any size can be taken any time, left to heal for a day or two (or several months), and rooted without hormones in practically any moist rooting mix without mist or bottom heat. Most nursery container soils should provide for good growth since this cactus is able to thrive in adverse soil conditions.

An unusual landscape element outside its natural range, candelabra cactus can be used in unwatered, well-drained landscapes where pedestrians do not stride close. During winter, all upright arching branches take on a reverse arch, giving the appearance of extreme wilt. Upon the return of frost-free weather, the arch is reversed once again. ►

◀ Pests are not expected, with the exception of one or more of the dreaded cactus mealy-bug species. These, however, are easily controlled with any number of insecticides.

Should the current market supply of *Cylindropuntia imbricata* not be sufficient to supply your needs, there are many ranchers in Colorado and New Mexico who would love to have you remove as many as possible from their lands.

Jim has been fooling around with native plants for more than 40 years in private, commercial, and public venues. His home garden contains 1000s of native plants, most grown from seed at home and now not supplementally watered for 20 years. Jim has written hundreds of articles, given talks too numerous to count, and continues to grow and plant the two or three native plants not yet in his garden. ☿



◀ "Phytoremediation..." continued from page 26

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Tips from the Pros

Can a Human Transplant Avoid Being a Weed on the Land?

By Dennis Swiftdeer Paige

Coming from northeastern Illinois, I was spoiled in terms of having adequate water, a temperate climate, very workable soil, and a longer growing season to boot. Not so when I came to the montane plant zone of Colorado. We moved here a little over four years ago and what I have learned as a native landscaper attempting to ecologically apply a healing approach to the land is to stand back and watch what your land is telling you.

I came here with several flats of native plants, ready to spread them around our half-acre spread and watch them flourish. I did my homework to make sure that these Illinois natives were the same species as those found in Colorado, like *Rudbeckia hirta*, *Rudbeckia laciniata*, *Geum triflorum*, *Polemonium pulcherrimum*, *Monarda fistulosa*, *Koeleria macrantha*, *Schizachyrium scoparium*, and *Silene regia*. I constantly watered these struggling plants during extended drought periods throughout our half acre spread with limited supply using the two barrels of water to which we were legally entitled.

By the end of the second growing season, only the grasses were able to flower and propagate, with most of the wildflowers not surviving. Planting plugs was a big mistake for montane conditions with such a short growing season: they attracted wildlife ranging from ground squirrels, gophers, voles, and rabbits to the always hungry mule deer. The wildflowers that did survive were visibly blooming for only a few days before being snipped off by one of the above.

However, I humbled myself and began to learn about the land by identifying the natives on our property that were popping up and blooming in small and large numbers, apparently not impacted by the lack of rain or wildlife activities. I saw wildflowers, grasses, and shrubs, like *Thermopsis montana*, *Thalictrum fendleri*, *Sedum lanceolatum*, *Rosa woodsii*, *Solidago multiradiata*, *Alnus incana*, *Ambrosia psilostachya*, *Artemisia ludoviciana*, *Antennaria rosea*, *Heterotheca villosa*, *Heracleum maximum*, *Galium boreale*, *Erigeron speciosus*, *Dodecatheon pulchellum*, *Chamerion angustifolium*, *Artemisia frigida*, ►



Purple locoweed (*Oxytropis lambertii*).
© Dennis Swiftdeer Paige



Monument plant (*Frasera speciosa*).
© Dennis Swiftdeer Paige



Bluemist penstemon (*Penstemon virens*).
© Dennis Swiftdeer Paige



Richardson's geranium (*Geranium richardsonii*).
© Dennis Swiftdeer Paige

◀ *Cryptantha virgata*, *Erigeron compositus*, *Erigeron melanocephalus*, *Erysimum asperum*, *Fragaria vesca*, *Frasera speciosa*, *Elymus elymoides*, *Dodecatheon pulchellum*, *Penstemon virens*, *Penstemon strictus*, *Campanula rotundifolia*, *Bouteloua gracilis*, *Lonicera involucrata*, *Lupinus argenteus*, *Mertensia ciliata*, *Muhlenbergia montana*, *Prunus virginiana*, *Dieteria canescens*, *Oenothera elata*, *Rubus idaeus*, *Rubus deliciosus*, and a couple dozen more.

I collected seeds from many of these Colorado native plants through the season and in late fall dispersed them in compost grenades, throwing them on the ground shortly before a heavy snowfall to make sure the crows and other opportunists would not eat them. I learned my lesson the hard way—I once introduced thousands of mixed native wildflower and grass seeds, only to have a murder of 50 gargantuan crows arrive the very next day to vacuum most of them up.

Knowing how dry this granitic soil is, I began to introduce ways to nurture the land to invite more wildflowers to thrive. Since we have several families of mule deer that regularly pass through our property, I gathered the deer pellets and dispersed them around the area as fertilizer. Since we have plenty of Douglas fir and pine cones spread throughout the property, especially when the ground is damp I walk around with ten pound weights fastened around my ankles and smash these cones down as mulch. It's good exercise to build up strength in the legs too.

I spent two years trying to catch tenacious gophers after spotting about 20 holes just inches away from each other. That sight made me livid, because I knew it meant it would be extremely difficult to introduce native plants around our home. After two years acting like the Bill Murray character in *Caddyshack*, using gentle methods at first but eventually resorting to lethal methods, I was able to trap and remove two

gophers. I did not use any pesticides or herbicides as I am opposed to introducing questionable chemicals to the property and impacting the food chain. I hand weed the thistles and mullein, which were abundant when we first came here but now are minimal. However, the dandelions are explosively abundant, but instead of eradicating them, I collect the flower heads and make a nutritional tea with this beneficial non-native. I tend to wait until the end of May to collect them, knowing how scarce wildflowers are in early spring in the montane zone for pollinators like butterflies and hummingbirds.

I hope that by nurturing native plants on our property, we will help introduce them to neighbors who might not be familiar with them yet, and inspire them to do the same. Last year I applied with the National Wildlife Federation to receive the designation of Certified Wildlife Habitat for our property, along with a sign stating the new status. We have a seasonal creek, scattered Douglas firs and ponderosas, and four newly installed wren-chickadee bird houses on opposite corners of our land.

We continue to grow in hands-on understanding as we enjoy a sense of bringing nature home to our little Colorado piece of the planet.

Dennis Swiftdeer Paige is an environmental educator and native plant landscaper, and the winner of several awards in native landscaping and habitat preservation from the Chicagoland area. He is the author of Community Eco-Gardens: Landscaping with Native Plants (published by Mcfarland and Company in 2021 with a foreword by Doug Tallamy), a book about a 19-year H.O.A. condominium native landscaping project where Dennis converted five acres of lawnscape into showcase eco-gardens and cultivated micro-habitats of wet/dry prairie, native woodland groves with understory, rain gardens, and a bioswale of seasonal wetland plants consisting of more than 170 native plants species. He is now retired and living in Conifer, CO. 🌀

***Spring Wildflowers of Utah's Red Rock Desert* by Peter Lesica and Walter Fertig**

Reviewed by Hollis Marriott

"Is there a good plant book for this area?" Most of us are familiar with this question, having either asked it or tried to answer it. Questioners probably hope for a book where they can match any plant to a photo. But if the respondent is an experienced botanist, she or he knows such hope is futile. Plants are diverse; most likely many kinds grow in the area. And small or subtle diagnostic characteristics often make identification difficult, beyond the power of photography to help.

Kudos then to the heroic botanists who take on the plant-book problem, especially those who emerge victorious!

The Book

Spring Wildflowers of Utah's Red Rock Desert covers southeast Utah and parts of adjacent states, including southwest Colorado.

Faced with the classic plant-book problem—2,700 species in this case—authors Lesica and Fertig pared the list down to 300 common plants that bloom in spring. In other words, if you visit in spring ("the best time of year to see wildflowers"), these are the plants you most likely will encounter. The title might suggest the book is limited to forbs, but trees, shrubs, and some of the more distinctive grasses are included as well.

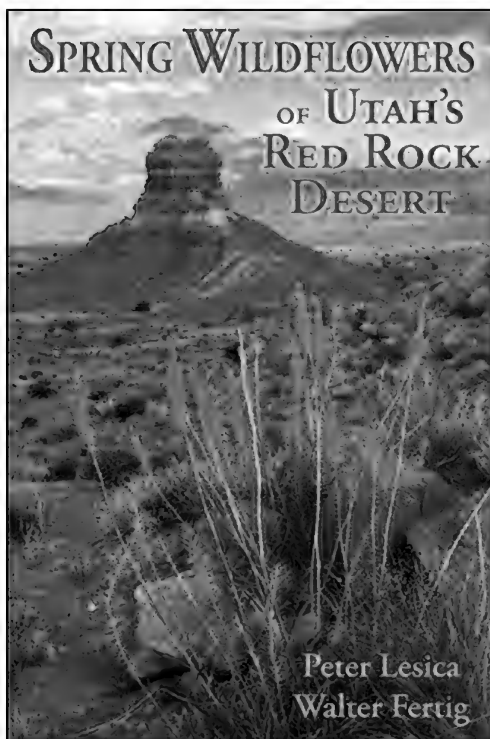
The book begins with the requisite introduction, which readers may be tempted to skip in a rush to name their unknown plants. Please don't! In addition to providing a description of the area—climate, geography, geology, and flora—the introduction gives valuable information about soil types and plant communities. These help in confirming identification (or not) once one arrives at a candidate species.

An especially important section is "How to Use This Book." Here we realize the authors truly are sympathetic to our plight: "Looking at all of those pictures to find the right one can be a daunting task." To help, they organized the book in a way that greatly reduces the number of candidates readers have to

consider. Plants are grouped hierarchically: first, by growth form (trees, grasses, and wildflowers including shrubs), then by flower color, and finally by flower features.

If your brain is like mine, you may find the written instructions a bit off-putting. But persevere! You will arrive at a final group of species, where you can peruse a reasonable number of pages in search of your mystery plant.

For each species, there is at least one photo and a description of diagnostic characteristics (a photograph alone rarely captures enough information to provide an accurate identification). A paragraph on habitat and range discusses the soil and plant community types mentioned above. Each treatment finishes with notes on topics, such as ethnobotany, biogeography, and similar or related species.



Does It Work?

I put the book to a test during a wet spring visit to Grand Staircase–Escalante National Monument. Between rainstorms, I was able to identify 22 of the 24 plants I posted to iNaturalist. No doubt my botany background gave me a head start—I don't know the flora but recognized many plants to family or genus. But determined novices who proceed carefully with the book in hand will be able to name many of their mystery plants, especially with practice.

Of course, there is much more to plants than the names we've given them. I especially enjoyed the authors' insights into plant lives. For example, when I investigated huge patches of yellow off the Cottonwood Canyon Road and found the Colorado Plateau stinkweed (*Cleomella palmeriana*) growing in abundance, I learned just how lucky I was. It "can turn gray clay barrens yellow for a few weeks following a wet winter, but then will be essentially absent in dry years." Growing with it was the tropical false goldeneye, *Heliomeris soliceps*, another ephemeral ►



Colorado Plateau stinkweed (*Cleomella palmeriana*) and tropical false goldeneye (*Heliomeris soliceps*) in the shale barrens. © Hollis Marriott

◀ shale barrens species. Both were in full bloom—a short-lived but fecund spectacle!

The Backstory

When I asked the authors about the birth of this book, they both mentioned their time long ago at the University of Montana, where their friendship began. Walt was an "impressionable" undergrad, and Peter Lesica an "herbarium rat . . . the special type of botanist who hangs out in an herbarium but is not paid to do so." After completing his degree, Walt went on to botanize in Wyoming, Utah, and Washington, while Peter worked mostly in Montana. But they kept in touch.

In the mid-1980s, Peter traveled to Canyonlands National Park in southeast Utah, a new SLR camera in hand. Seduced by the flora, he returned year after year. After realizing he probably had enough photos for a wildflower book, he asked Walt—who had compiled plant lists for southern Utah's major national parks and monuments—to be coauthor. Their complementary knowledge and skills produced this book.

Lesica P and Fertig W. 2018. *Spring Wildflowers of Utah's Red Rock Desert*. Trillium Press. Distributed by Mountain Press, Missoula, MT.

Hollis Marriott started her botanical adventures in the deserts and chaparral of California. In 1977, she was lured to Wyoming by a seasonal job at Devils Tower National Monument. Now, after working for 40-plus years as a field botanist in Wyoming and South Dakota, she is retired, at least theoretically. But that doesn't keep her away from plants. She is a member of the Wyoming, Colorado, and Great Plains Native Plant Societies, and is part of a group revising Theodore Van Bruggen's *The Vascular Plants of South Dakota*. Her travels in the American West always include botanizing. She lives in Laramie, Wyoming, and can be reached at her blog, *In the Company of Plants and Rocks* (<http://plantsandrocks.blogspot.com/>). ☯

Morning Glory

By Janet Fichter

Oh waking morning glory arrayed in colors bright,
Like me, a weed of tangled path just searching for
the light.

Your opening eyes of color are looking for the sun.
Once light is found, your colors round can rest, the
search is done.

Persistent in your yearning, you loose the chains
of dirt.

Your growing maze drinks in sun rays to quench
your daily thirst.

Nature's example of life come from light
Resting in shadows; persevering the night
Morning light's promise sets prisoners free
Creation now colors a life meant to be.

Oh, steadfast morning glory, in you this truth I see:
A new day's dawn means life goes on, and there's
beauty in each weed.



Bush morning-glory (*Ipomoea leptophylla*).
© Loraine Yeatts

News, Events, and Announcements

Please check the **Calendar of Events** online at <https://conps.org/mfm-event-calendar/#!calendar> for up-to-date information on chapter meetings, garden tours, and other events. With the evolving COVID-19 situation, the status of in-person CoNPS events might change.

CoNPS may offer some chapter meetings, workshops, and lectures as webinars or other online meetings. Others might be postponed or canceled. Information will be posted online and will be promoted via the CoNPS E-News.

CoNPS Society-Wide Events

September 15, 6:00–8:00 PM
CoNPS iNaturalist Working Group
Presenter: Maggie Gaddis

Join Dr. Maggie Gaddis for an evening of plant identification using iNaturalist. We are working on curating iNaturalist observations. We focus on the CoNPS Budburst species first. We look in Ackerfield and Weber/Wittmann to ascertain what needs to be seen to identify the species. Then we go into iNaturalist and confirm photographic observations of these species based on the key information. This elevates quality observations to research-grade status, thereby making this data available for research opportunities...like our BudBurst project! Come one, come all! No prior experience required. You will be sent the meeting link 24 hours prior to the meeting. Virtual Meeting

September 18, 1:00 PM
Celebration of the Life of Jack Carter

Jack's family will be hosting the service on Zoom because so many of his family members and friends live all across the country, enabling more of his family and friends to attend. If you are interested in attending the celebration, please reply to Jack's daughter, Diane Carter, at dianecarterlrc@gmail.com. Diane will be able to send you the Zoom link for the celebration as the day draws near.

Jack's family and a number of Jack and Martha's friends will be sharing memories of his life and commitment to plant-sciences education.

CoNPS TO RECEIVE CAEE AWARD

Colorado Alliance for Environmental Education, the state professional organization for environmental educators, is awarding CoNPS a *2021 Award of Excellence in Environmental Education for Outstanding COVID-19 Program Response and Adaptation*, for webinars initiated and implemented in 2020 in lieu of workshops and field seminars due to the COVID-19 pandemic. These webinars: (1) provided an opportunity to fulfill the education mission of CoNPS while ensuring a safe environment for participants via online programs; (2) offered the same high-quality, comprehensive native-plant programs for ALL participants throughout the state; (3) provided cost savings for participants and increased revenues for CoNPS; (4) created the opportunity to develop a Special Speaker Series, featuring nationally and internationally known speakers who presented programs on a variety of native-plant-related topics; (5) doubled program participation and produced very positive program impact (as evidenced by participant evaluations). Stay tuned for more information in the next *Aquilegia*.

CoNPS Webinars

CoNPS offers webinars on a variety of native plant topics. Sign up for these webinars on the CoNPS website (<https://conps.org/mfm-event-calendar/#!calendar>). New webinars are constantly being added to the calendar

Wildscaping 101–Native Plants for Birds
Sunday, September 19, 1:00–3:30 PM
Presenter: Kate Hogan, MS

Are you passionate about native plants and want to learn more about the ecological connections between our natives and our Colorado bird life? Join us for an

engaging and exciting webinar on ways to diversify the birds found within your neighborhood or your own backyard using a variety of food groups provided by our native plants. We will cover some of the science behind the essential need for native plants within our landscape, and review the *Native Plants for Birds* handout that was created in partnership with Denver Audubon, CoNPS, Audubon Rockies, and CSU Extension.

This webinar is designed for all skill levels of native-plant enthusiasts. Part of the *Gardening with Native Plants Series*. ►

◀ Kate Hogan has worked in the field of ecology for more than 20 years. She holds a bachelor's degree in natural science and biology from the University of Puget Sound, and a master's degree in nonprofit management from Regis University. For the past six years, Kate has worked as the community-outreach coordinator at Denver Audubon, where she creates strategic partnerships that help fulfill the

organization's mission to "inspire actions to protect birds, other wildlife, and their habitats through education, conservation, and research." She presents outreach programs throughout the Denver metro area and manages the Audubon Center at Chatfield, providing public programs and events for visitors who desire a deeper connection to nature. ☞

CoNPS Chapter Events and Updates

Metro-Denver Chapter

Second Tuesday of each month, 6:30-9:00 PM

Hybrid In-Person and Virtual Meetings

Location: Sturm Family Auditorium, Freyer-Newman Center, Denver Botanic Gardens

Northern Chapter

Despite many of our favorite destinations being destroyed by fire last year, we had several new hikes on unique topics.

In early June, Stacey Anderson led us on a moss tutorial at Gateway Natural Area just up the Poudre River. Maddie Maher led two: one up the ever-popular Wells Gulch in Lory State Park, and the other on the Sundance Trail at Carter Lake State Park. Also in June, we ventured onto the Eastern Plains with the Boulder chapter and visited the Black Canyon Bison Ranch east of Pawnee Buttes, where we saw many plains-endemic species. Ronda Koski led a trip at Redstone Mountain Open Space. Kathleen Maher conducted an evening garden walk at River's Edge Demonstration Gardens in Loveland.

In July, we escaped the heat of the Front Range (but not the haze from fires!) and visited the Snowy Range with Stephen Hauptli. There we saw buckbean, a little aquatic with a genus all to itself in Colorado: *Menyanthes trifoliata*. We capped off the field trip



Astragalus species, mat-forming, seen on the plains, possibly *A. tridactylus*. © Ann Grant

season in August with a visit to Andy Goris's property in Redstone Canyon, led by him and Ed Ogle, on a photography-oriented exploration.

We will have a couple of last hurrahs in the way of pop-up garden walks, so watch the calendar. Our evening meetings start up again after the Annual Conference in September, the first Tuesday of the month; the first few will be via Zoom.

August 28, 8:30–9:30 AM

Meet the Natives Garden Tour at River's Edge Natural Area in Loveland

September 4, 4:00–6:30 pm

Seed Collection at Northern Water

Southeast Chapter

Volunteer Workdays

Kathleen Marriage Garden at Sonderrmann Park

740 W. Caramillo St., Colorado Springs

August 24, 4:30–6:30

September 7, 4:30–6:30 PM

September 21, 4:30–6:30 PM

Volunteers of all ages and abilities are invited to join us to install and maintain this historic native garden. Projects will vary month to month. Bring work gloves, sunscreen, sturdy shoes, water, snacks, and layered clothing for our ever-changing weather. Additional watering needed in between events if you are available! Parking is limited, you may need to use cul-de-sac or Chestnut Street. Contact: Maggie Gaddis, ecocitycoloradosprings@gmail.com

August 27–29, 2021

City of Colorado Springs

Stratton Open Space BioBlitz

Team leader: Curt Nimz

Three-day event for scientists and members of the public to collect data on the variety of species present in the boundary of the park. Come join fellow scientists and outdoor enthusiasts to explore and record your findings on iNaturalist. There will be food, information tables, and guided hikes to connect with the public and like-minded individuals.

Please contact Curt at curtnimz@gmail.com for specifics, including times and sign-up information, about this event. ☞

Cross-Pollination Events

Save the Date!

Landscaping with Colorado Native Plants Conference

Saturday, February 26, 2022



The conference will be online again this year. Registration will go live in December—check our website for details:
<https://landscapingwithcoloradonativeplants.wordpress.com/>

Doug Tallamy, author of *Bringing Nature Home* and *Nature's Best Hope* will be our Keynote Speaker.

September 14-16
Oklahoma Native Plant Society Annual Meeting
Stillwater, Oklahoma
<https://www.oknativeplants.org/annual-meeting.html>

September 16-19
Gila River Festival
“(Re)Connect with the River”
Silver City, New Mexico
www.gilariverfestival.org

September 19-22
Western Collaborative Conservation Network
Paradise Valley, Montana
<https://collaborativeconservation.org/>

September 21-23
Colorado Wildland Fire Conference
Grand Junction, Colorado
<http://www.wildfire-colorado.com/>

September 25
National Public Lands Day

October 4-8
Colorado Parks and Recreation Association
“CPRA Heroes”
Virtual
<https://www.cpra-web.org/page/VirtualAnnualConference>

October 5-7
Sustaining Colorado Watersheds Conference
“Together Like Never Before”
Avon, Colorado
<https://www.coloradowater.org/scw-conference-2021>

October 11-13
Colorado Open Space Alliance
“Expect the Unexpected: Building Resilience to Adapt to Change”
Vail, Colorado
<https://coloradoopenspace.org/conference>

October 19-21
North American Pollinator Protection Campaign
International Conference
Virtual
<https://www.pollinator.org/nappc/conference>

October 19
Natural Areas Conference
“Life from the Ashes: Exploring the Impact of Prescribed Fire & Natural Fire on Insects and Other Invertebrates”
Virtual
https://www.naturalareas.org/2021_natural_areas_conference.php

October 24-31
Bat week

November 6
National Bison Day

Erratum

The spring issue of *Aquilegia* (volume 45, number 2) inadvertently stated that CoNPS has a training module on the ethics of plant collection (page 7). In actuality, CoNPS has a published document on the ethics of plant collection but does not offer a full training module. The text of the entire document on CoNPS can be found at https://conps.org/wp-content/uploads/2017/02/Ethics_of_Collecting_CoNPS_Approved_10-5-2013.pdf

Member Profile: Alice Eastwood Scholarship Awardees



Grace Gardner with *Aquilegia micrantha*.

I am currently a senior at Colorado Mesa University, studying biology with an ecological and organismal concentration, a minor in chemistry, a love for native plants, and a lot of excitement for the future!

My interest in native plants started early. Growing up in western Colorado's

Grand Valley, I was surrounded by breathtaking landscapes and impressive flora. From cactus blooms and evening primroses growing on the foothills of the Book Cliffs to brilliant Indian paintbrush displays on top of the Grand Mesa, I loved it all. My interest in the identification, preservation, and stewardship of these beautiful plants grew with time and age as I learned about the rapidly changing climate and mourned the loss of biodiversity that accompanies this phenomenon.

For two summers now, I have worked in native plant identification and preservation, adding to a floristic inventory project in 2020 and studying the distribution of a rare species, *Sclerocactus glaucus*, in 2021. My passion for preserving biodiversity and ecological health through work with native plants only continues to grow with these experiences, as I fall more in love with the plants' beauty and impact.

My short-term goals include pursuing work and in-class experiences with native plants throughout the last year of my undergraduate degree, earning a chemistry minor, and graduating with my bachelor's degree in 2022. My long-term goals include pursuing a master's or doctoral degree either in soil science or a more macro-focused aspect of botany or horticulture, then eventually working in some facet of sustainable agriculture.

I am specifically interested in helping to shift such a necessary industry toward management that is safer for the people it serves and less damaging to a rapidly deteriorating climate. Many of the practices currently in place in agriculture contribute to the destruction or desiccation of the ecosystems and native plants that matter so deeply to the future of our planet, and I look forward to working toward solutions that will be safer for producers, consumers, livestock, and our planet.

I applied for the Eastwood Scholarship after hearing about it from my research advisor at the time, Dr. Stephen Stern. I worked with Dr. Stern during the summer of 2020 on an ongoing project compiling a comprehensive floristic inventory of the McInnis Canyons National Conservation Area in western Colorado. During that internship, I collected several *Aquilegia micrantha* specimens in shady alcoves. They were among my favorite collections, so I connected to this journal as soon as he forwarded the scholarship information to me.

My knowledge of Alice Eastwood also has roots with Dr. Stern, going back to the first plant biology class I took from him during my freshman year of college. We learned about botanists throughout the ages, focusing on botanists who studied the native plant populations in Colorado. Alice Eastwood was one of the botanists who stood out to me the most. She famously saved type collections from burning during the 1906 San Francisco earthquake, and the image of a recklessly devoted botanist thinking only of saving her specimens in the midst of disaster is not easily forgotten.

Alice Eastwood's story continues to inspire me. Her love for nature, success as a female botanist in the early 1900s, and dedication to her work serve as examples of passion and drive, and she remains an impressive role model to me. I was honored to receive the scholarship offered by the Colorado Native Plant Society in her name, and am excited to put it to good use in continuing my education this fall.



Tiffany Gentry with *Mertensia ciliata*.

Four years ago, I enrolled in the biology undergraduate program at CU Denver. I was not sure what I wanted to specialize in at the time, but I knew I would find the answer along the way. During these four years, I became an avid hiker and bought field guides to aid in identifying

wildflowers. The more I leaned into this new hobby, the faster my answers came. I studied plant evolution in general biology, and this further sparked my interest. ►

◀ I reached out to Dr. Molly Nepokroeff, senior instructor on plant diversity and flora of Colorado, as well as to professor emeritus Dr. Leo Bruederle, for their advice on how to maximize my studies with the goal of becoming a botanist. Both professors provided invaluable feedback. They recommended specific courses, future research considerations, and additional learning opportunities. Dr. Bruederle recommended taking the Plant Diversity and Flora of Colorado classes, so I immediately enrolled.

After I started Dr. Nepokroeff's Flora of Colorado class, she forwarded me the Alice Eastwood Scholarship and Fellowship applications. I was so excited about the possibility of continuing my education and expanding my knowledge of plants through the fields of systematics and taxonomy. Around this time, I also began an internship at the Denver Botanic Gardens studying the impact of seed harvest on rare annual species with Michelle DePrenger-Levin. This was my first experience in botanical research, and it solidified my interest in pursuing the Alice Eastwood Scholarship and Fellowship. I knew winning the fellowship and scholarship would mean being mentored by experts in this field: Dr. Bruederle and Dr. Jennifer Ackerfield. These were once-in-a-lifetime opportunities.

Doubt and fear quickly set in as I read over the application process. I didn't want to get my hopes up, and was terrified of rejection. The reality was that I had nothing to lose and everything to gain. So, I decided to apply and put everything I had into the process. You cannot imagine the shock and overwhelming joy I felt when I read the email stating I had won! Winning the Alice Eastwood Scholarship and Fellowship is not about tacking on another line item for a resumé. This is life changing for me.

For the past four years, I worked in an unrelated field while attending school. I spent every day dreaming about working full-time as a botanist. These awards give me the opportunity to work in a field I genuinely love and appreciate. I will be a full-time graduate student and teaching assistant in the fall. Showing up to work every day will mean I'm another step closer to a career as a botanist. I am one step closer to contributing to the conservation and preservation of our natural world. For me, there is no higher calling or anything I find more fulfilling.

These awards provide the framework and guidance I need to really kick-start my career. Thank you to everyone at the Colorado Native Plant Society and the Denver Botanic Gardens; and to Dr. Bruederle, Dr. Ackerfield, and Dr. Nepokroeff for providing me guidance and believing in me. ☺

Plants in the News

Plants have been featured in several news articles recently.

Cattle, Conservation, and Carbon

Sequestration. Pertinent to our annual conference's theme, an article on the role of synergy in Great Plains ranching and conservation in the sequestration of carbon into the soil has won an Editor's Choice award from the Soil and Water Conservation Society. A key conclusion in this paper is that "Keeping rangelands intact is the single most important action for maximizing soil carbon stocks in western Great Plains rangelands."

<https://www.jswnonline.org/content/75/1/5A>

Phytomining. In addition to plants helping to prevent pollution and remediate toxic soils (see Fuselier's article on page 22), plants may also be used to recover specific elements. Several companies are exploring the possibility of using plants to extract minerals from soil (phytomining). Field trials have already proven the ability of *Phyllanthus rufuschaneyi* to accumulate enough nickel to be profitable. Other 'hyperaccumulator' plants may prove useful in extracting zinc, cobalt, and gold. <https://grist.org/science/phytomining-nickel-kinabalu-park-malaysia/>

New Plant Species Discovered in Rocky

Mountain National Park. The small, fernlike wishbone moonwort was recently discovered in RMNP by retired USFS botanist Steve Popovich. This species had not previously been found in Colorado. <https://www.cpr.org/show-segment/new-plant-species-discovered-in-rocky-mountain-national-park/>

Carnivorous plants. A plant common to the wetlands of mountains along the west coast of North America turns out to be carnivorous. What secrets might we find in our Colorado native plants if we look closely enough?

<https://www.nationalgeographic.com/animals/article/newfound-carnivorous-plant-lives-in-mountain-bogs>
<https://www.pnas.org/content/118/33/e2022724118>

Cataloging Plants of the Gila Cliff Dwellings

National Monument. *New Mexico Magazine* ran an article on the efforts of several botanists to completely catalog all the plant species that can be found in the Gila Cliff Dwellings National Monument. An important point of the article is new discoveries continue to be made, even after nine years of field trips. <https://www.newmexico.org/nmmagazine/articles/post/botanists-identify-plants-gila-cliff-dwellings-national-monument>

CoNPS Membership

Name _____
 Address _____
 City _____ State _____ Zip _____
 Phone _____
 E-mail _____
 Chapter (if known) _____

- ☐ New ☐ Renewal
- ☐ Student \$17 ☐ Senior (65+) \$17 ☐ Individual \$25
☐ Family \$35 ☐ Plant Lover \$50 ☐ Supporting \$100
☐ Patron \$250 ☐ Benefactor \$500 ☐ Life Member \$800
- ☐ **Printed Color Copy** of the newsletter, *Aquilegia*, \$20

CHAPTERS: Boulder, Metro-Denver, Northern (Ft. Collins-Greeley), Plateau (Grand Junction & West Slope), Southeast (Colorado Springs-Pueblo), Southwest (Durango) or Unaffiliated

If this is a change in address, please write your old address here.

Address _____
 City _____ State _____ Zip _____

- ☐ **Check box to receive information on volunteer opportunities**

DUES include the electronic version of the *Aquilegia* newsletter, published quarterly.

The 36-page, full color electronic publication arrives by PDF in member email boxes in February, May, August, and December. For those members without email addresses, please apply for a scholarship to receive print copies.

Membership dues cover a 12-month period.

You may also join online at <https://conps.org/about-us/committees/join-us/>

CONTRIBUTIONS to CoNPS are tax deductible:

John Marr fund for research on the biology and natural history of Colorado native plants \$ _____

Myrna P. Steinkamp Memorial fund for research and other activities to benefit the rare plants of Colorado \$ _____

Alice Eastwood Scholarship fund to help support undergraduates pursuing bachelor's degrees that ultimately advance the Mission of the Society \$ _____

Total included: \$ _____

Please make check payable to:
Colorado Native Plant Society

Send completed form and full remittance to:
 CoNPS Office
 PO Box 200
 Fort Collins, CO 80522

Save the date for the Landscaping with Colorado Native Plants Conference, Saturday, February 26th, 2022.

The conference will be online again this year. Registration will go live in December—check our website for details: <https://landscapingwithcoloradonativeplants.wordpress.com/>

Doug Tallamy, author of *Bringing Nature Home* and *Nature's Best Hope* will be our Keynote Speaker.

The Landscaping with Colorado Native Plants Conference promotes the inclusion of native plants in our landscaping to benefit pollinators and songbirds, save water, and restore the beauty and health of nature in the places we live, work, and play.

While we recommend the use of straight species and local ecotypes wherever possible, we support the use of varieties and cultivars of native species as long as their breeding doesn't interfere with their ability to function in nature and maintain key relationships with pollinators and other lives.

Sponsor for the 2020 CoNPS Annual Conference.

Thank you for your support and for the native plant stock that you provide!



Can You ID These Prairie Flowers?



Answers: (clockwise, from upper left): silky milkvetch (*Astragalus sericoleucus*), white penstemon (*Penstemon albidus*), plains flax (*Linum puberulum*), silver-mounded cat's-eye (*Oreocarya cana*), lavender-leaf sundrops (*Oenothera laevandulifolia*), plains phlox (*Phlox andicola*). © Marlene Borneman

Colorado Native Plant Society



P.O. Box 200
Fort Collins, Colorado 80522
<http://www.conps.org>

Mission Grant deadline extended to August 31st!

Do you have a project that contributes to the CoNPS mission of growing knowledge, appreciation and conservation of native plants and habitats in Colorado? If so, please find the submission guidelines on the CoNPS website. Contact Christina Alba with any inquiries (christina.alba@botanicgardens.org).

45TH Annual CoNPS Conference “The Short Grass Prairie...



...and a Long Look Back”